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The Problem of Evaluating the Long-Term Development of the Electronic Data Processing Capacity in the Socialist Republic of Romania

> *"The socialist society, which people are consciously building, starting from the scientific Marxist-Leninist world outlook, is deeply interested in utilizing the achievements of science, with a view to developing the economy and culture, for the multilateral flourishing of human personality."*
>
> **Nicolae Ceauşescu**

One of the field of great importance for modern society, characterized both by the extremely fast development of the production technology and by the generalized use in nearly all areas of economic and social life, is that of electronic data processing.

Initially elaborated as a chapter of a prognosis concerning the field of computer technology and utilization in general, this study of the probable, respectively, possible evolution of the electronic data processing in our country sharply emphasized the significance of economic implications. On this basis, the authors have come to the conclusion that a partial publication of the study is justified, in order to posing its conclusions for discussion. Of course, the points of view expressed are of strictly personal nature, a position which, as a matter of fact, is typical for most of the prognosis studies.

The authors started from the following basic premises:

a) the evolution of the use of computers on the world level can be extrapolated on the basis of the present day data and it will necessarily influence the situation in our country;

b) the evolution of the electronic data processing capacity in our country is determined, on a short and medium-term, by the programmes adopted

by the highest party and state leadership [1]; on a long term, the influence of the evolution on the world level should increase its importance;

c) for general estimations (also characteristic of the prognosis studies) it is sufficient to use a small number of indicators which reflect several essential coordinates.

The relatively recent introduction of the electronic data processing in our country requires a careful consideration before extrapolating of information available.

1. THE PRESENT STAGE OF THE EQUIPMENT OF THE SCCIALIST REPUBLIC OF ROMANIA WITH ELECTRONIC DATA PROCESSING TECHNIQUE

The equipment of the national economy of the Socialist Republic of Romania with electronic computers has witnessed since 1967 a rapid development following the special attention granted to this sector of activity by the party and state leadership; it is part of the continuous effort made in our country for improving the organization and management of economy-both at the microeconomic and at the macroeconomic level, for using advanced methods of measuring the results of economic activity of planning and of preparation of short term and long term decision.

The adoption in 1967 of the first national programme of equipment with electronic computers has stimulated the rapid growth of the data processing potential, both by the import of computer systems and also by the setting up of an own production basis in this field. It must be mentioned here that a great part of data processing facilities installed today in the Romanian economy is made up of FELIX type computers, manufactured in our country.

As the number of computers does not represent an indicator accurately suggesting the degree of equipment with computer power, it is proposed in this study to estimate the level of equipment through the total installed processing capacity, expressed either in absolute units or per capita. As a first approximation, the processing capacity may be considered equal to the total computing speed of the installed equipment obtained by cumulating the computing speed of all existing systems. The processing capacity can be expressed in operations/second, where by operation we usually mean a complete fixed point addition.

The authors are aware of the fact that the indicator "processing capacity", as it was defined above, does not entirely reflect the potential of a given number of data processing electronic equipment.

Since the quantitative estimations whcih follow have an orientative character, it is suffcient to consider average configurations which with an acceptable approximation represents the computing speed function (as it is suggested, among other things by the existance of mean cost-computing speed empiric curves) [2].

It is interesting to note that between 1967 and 1972, the average rate of increase of the processing capacity has caused, approximately, its doubling every year (Fig. 1), a fact which corresponds to the present trends in the developed Western countries.

2. THE PROGNOSIS OF THE TENDENCIES OF INCREASING WORLD'S ELECTRONIC DATA PROCESSING CAPACITY IN THE 1972—2000 PERIOD

Though the present estimations of the rate at which activity in the field of electronic data processing will develop in the industrially advanced countries, in the coming decades, are characterized by a high level of approximation, both the users and the manufactures consider, in general, that by the end of the century the computer industry will probably occupy the first place among industrial subbranches, from the point of view of the value of the production output [3]. At the same time, the utilization of electronic data processing systems will have itself one of the particularities of industrail processes, turning into "a transforming industry" of the kind of that for the production, transmission and distribution of electric power [4].

This paragraph will present only one of the aspects of the development of the computing technique in some developed Western countries, namely, the way in which the capacity of data processing is estimated to increase in the next 20—25 years. Elements of prognosis on the evolution of this index are given in literature for the United States [5]. At the same time, taking as a basis the rate of growth of the number of computer systems in other countries, in the 1965—1975 period and, by extrapolation in the 1975—1995 period, an approximate image of the possible evolution of the data processing capacity of these countries for the next decades can be obtained. (reference is made only to the Federal Republic of Germany, Great Britain and France).

It results from [6] that in the 1975—1990 period, the data processing capacity of the United States will increase tenfold every two and a half years, a fact which would lead, in 1995, to the obtaining of a level whose values seem, at least, in the present terms, extraordinary large: approximately 10^6 MOS*) (it is reminded that the entire world's data processing capacity in 1970 was approximately of 10^4 MOS).

As a matter of fact, prognoses made for the above mentioned countries lead to the somewhat more careful estimation of a tenfold increase of the data processing capacity every five years, a speed which will be considered as possible. Of course, it is difficult to estimate the probability and importance of a saturation in the equipment with electronic data processing capacity. Certain older estimations consider the possibility for a saturation to appear after shortly the year 2000; the recession occured in the electronic industry, including computers, in the 1970—1971 period, may suggest that this term might be closer. Nevertheless, the intensification of the achievement of networks of interconnected computers, and in general, the increase of the importance of the real time systems, suggests the fact that the society will continue to rapidly increase its data processing capacity, a role and an evolution similar to those of power resources being conceived for this domain. However, to raise the caution of estimations, the possibility of a lower rate will also be considered, namely, the tenfold increase of the data processing capacity every ten years; the authors consider this rate minimal, although present estimations do not suggest this (Fig. 2, table 1).

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*) 1 MOS = 1 million operations per second.

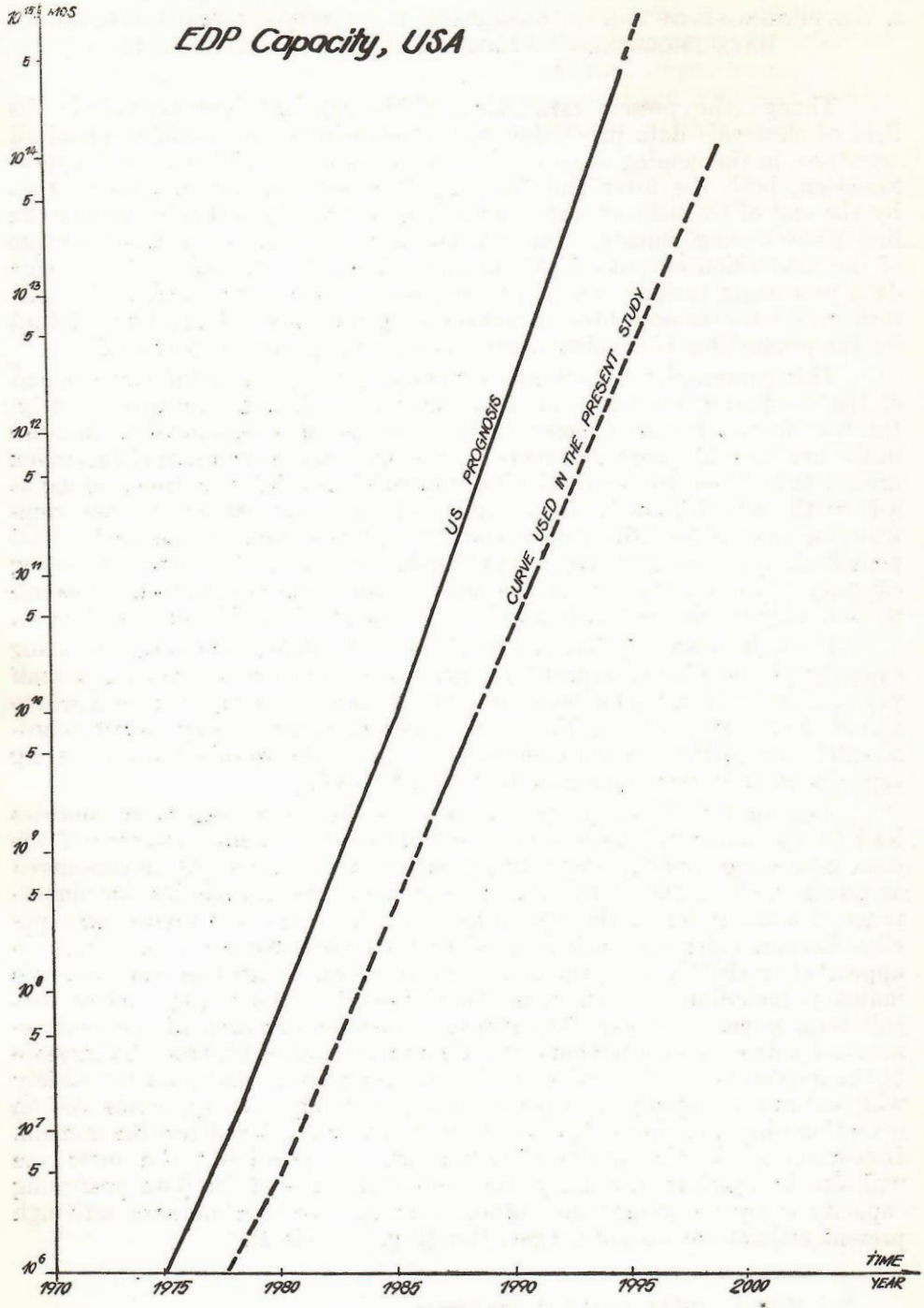
EDP Capacity, USA
MOS
US PROGNOSIS
CURVE USED IN THE PRESENT STUDY
TIME
YEAR
1970
1975
1980
1985
1990
1995
2000

Fig. 1

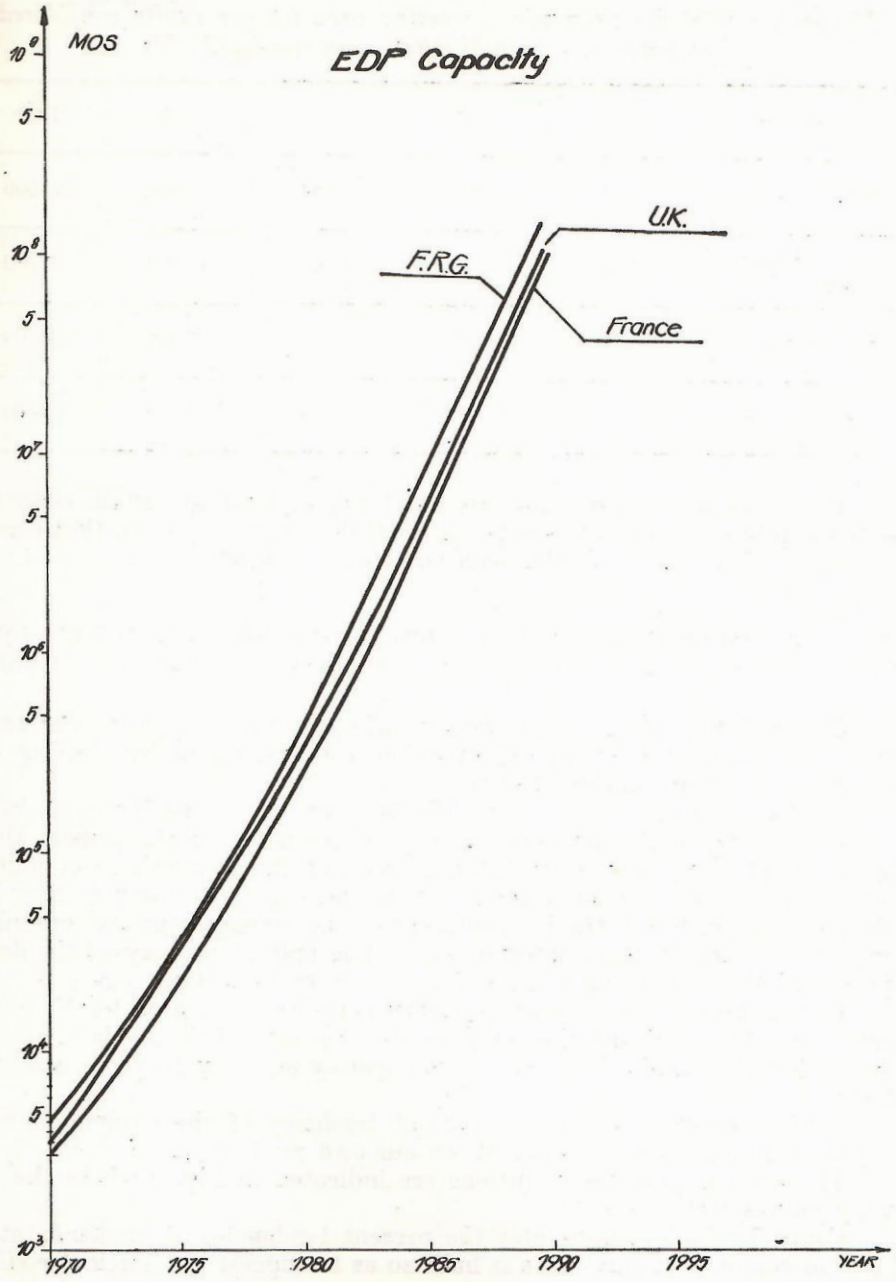
MOS
EDP Capacity
U.K.
F.R.G.
France
10^9
5
10^8
5
10^7
5
10^6
5
10^5
5
10^4
5
10^3
1970
1975
1980
1985
1990
1995
YEAR

Fig. 2

Table

*The evolution of the electronic processing capacity per capita considered probable in certain Western countries (OSL) **)*

Country	1970	1975	1980	1985	1990
U.S.A.	35	330	3 200	30 000	260 000
Federal Republic of Germany	12	110	1 100	10 000	97 000
Great Britain	9	85	820	7 800	72 000
France	8.5	80	720	7 300	69 000

It results from above that around 1990, at least in certain countries the per capita edp capacity will possibly attain a value equal to that corresponding in 1970, to a medium scale electronic computer.

3. OPTIONS CONCERNING THE EVOLUTION OF THE NECESSARY ELECTRONIC DATA PROCESSING CAPACITY OF THE SOCIALIST REPUBLIC OF ROMANIA

The evolution of the necessary level of electronic data processing capacity for the Socialist Republic of Romania can be estimated by starting out from the following considerations:

a) the realization in the next 15—20 years of a capacity comparable to that existing in the developed European countries, at the present time. This point of view derives from the outlook of the Romanian Communist Party on Romania's economic-social development in the coming decades [7], a development in which the improvement of the management and organization of the economic- social information system and, implicitely, of the development of the computing technique hold a very important place;

b) the level of the present necessary capacity (estimated for 1970 between 10 and 20 MOS) and the possible rate of growth of the needs (it is considered that the tenfold increase of the capacity at every 10 years is admissible);

c) the extrapolation of the present tendency of the equipment with computers, based, to a great extent, on our own production.

The various possible evolutions are indicated in Fig. 3 where the following curves were indicated:

Curve 1 which extrapolates the present tendencies of implementation of digital computers; this curve is built so as to suggest the particular effort made to increase the data processing capacity in the present period, and

**) OSL = 1 operation per second per capita.

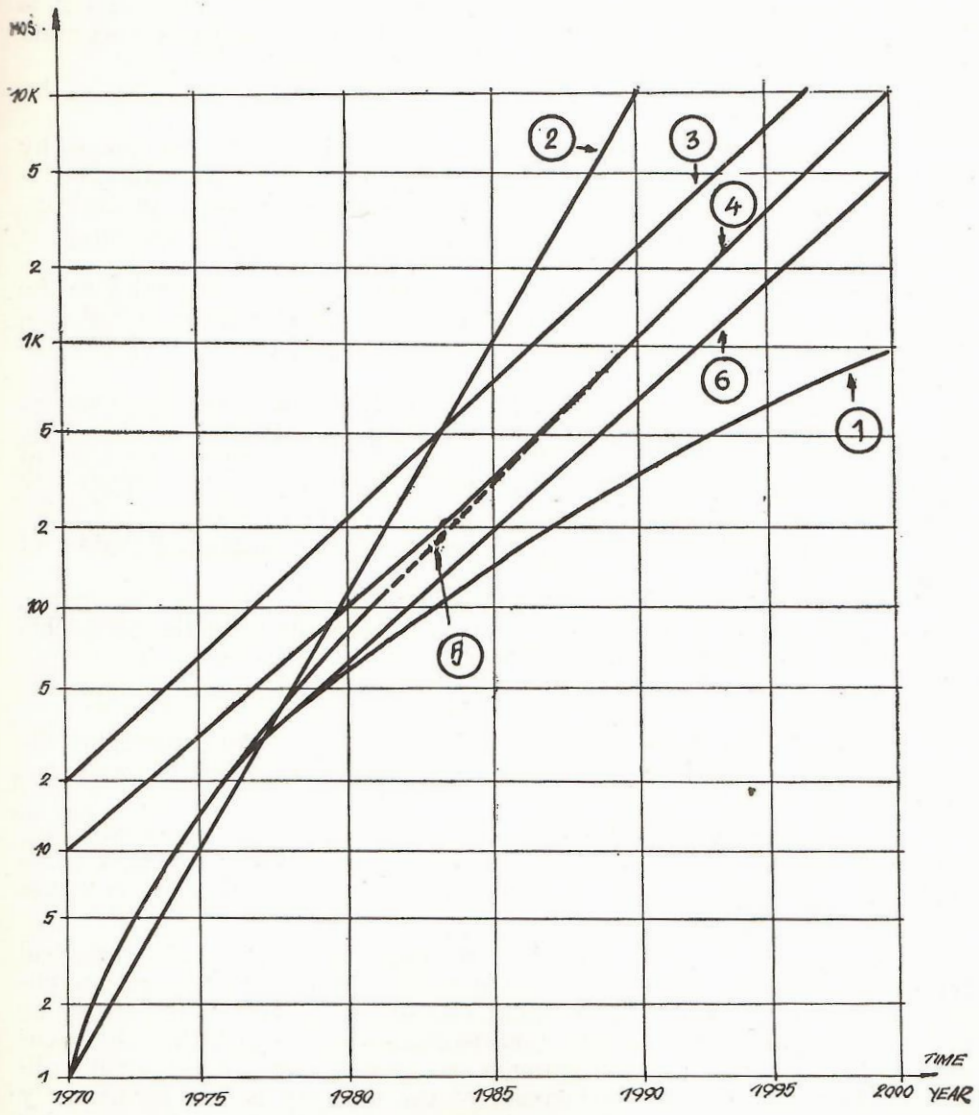
TOTAL NECESSARY CAPACITY
MOŚ
10K
5
2
1K
5
2
100
5
2
10
5
2
1
1970
1975
1980
1985
1990
1995
2000
TIME
YEAR
1
2
3
4
5
6

Fig. 3

also as a tendency of growth at a reduced rate in the future, in the hypothesis that the home production will be oriented on systems whose speed will not increase substantially (for example, by an order of magnitude from a development stage to another). This evolution is rather improbable since the technical progress imposes to speed up the increase of the data processing capacity.

Curve 2 — shows the increase of the capacity at the rate accepted as possible on the world level assuming as starting point the 1970 level, a tenfold increase of capacity every 10 years. This curve underlines the intense growth of the processing capacity during the years 1970—1980, and it is leading after 1980 to very high values. It must be interpreted as a maximum possible evolution, yet improbable due to two factors:

— the extremely large investment effort implied by such an evolution;

— we did not take into account the favourable conditions offerred by the socialist economy as to the more efficient use of material resources, including the computing facilities, in comparison with the conditions in the Western countries where the economic organizations are equiped according, in general, to their own criteria.

Curve 3 shows the increase of the necessary capacity according to the rate (a tenfold increase of the capacity every 10 years), with an initial estimated necessary capacity on the national economy of the order of 20 MOS in 1970.

This curve represents a probable tendency of the necessary capacity.

Curve 4 is similar to curve 3 with a starting capacity of 10 MOS in 1970, a level which would have corresponded, approximately, to the capacity of urgent needs for the management of the production processes. This curve is considered to represent a cautious estimation of the evolution of the capacity of electronic data processing necessary for the Socialist Republic of Romania.

Curve 5 demonstrates one of the possibilities to intensify the growth of computing power (a rate ranging between the posible and the admissible world one), in order to connect the level of equipment according to curve 1 to the evolution of the needs, according to curve 4. This curve represents a desired evolution.

Curve 6 shows the continuation of the increase of the capacity at the rate admissible after 1980. This curve represents an evolution considered as minimal.

From the analysis of the curves represented in Fig. 3, it results that the effort to raise the capacity of electronic data processing will have to be continued and intensified for a longer period, the minimal orientation values being given in table 2.

In any case, it can be said that an equipment based on the numerical increase of a single type of electronic computer (thus, with a single computing speed) will not ensure a sufficient rate of the increase of the electronic processing capacity (taking into consideration also the fact that the number of systems with which the national economy can be equiped is not unlimited). More exactly: if the increase of the capacity is not permanently achieved at a high rate (as that in the present period), the appearance of a

deficit even for relatively close periods (around 1980) is foreseen and, in the next decade, it can grow rapidly, attaining values of 100—300% of the installed edp processing capacity.

Table 2

Minimal capacity

OSL

1975	1980	1985	1990
3	7	18	50

In the author's opinion, 1975 represents the latest time when the major technical, economic and social options for ensuring the necessary long-term capacity of electronic data processing will have to be taken.

4. OPTIONS CONCERNING THE NECESSARY EFFORT TO ENSURE THE CAPACITY OF ELECTRONIC DATA PROCESSING

The estimation of the necessary effort for ensuring an evolution of the equipment with electronic data processing capacity considered as admissible (curve 5 or curve 6) raises serious problems as regards the provision of financial and human resources.

4.1. Estimation of the financial effort

To get an approximate general image, the following working hypotheses were admitted initially:

I. the costs of the systems will not deviate sensibly from the present ones;

II. three types of electronic computers defined by the speed: 0.2 MOS, 2 MOS, 20 MOS can be taken into consideration;

III. the share of the minicomputers will grow and they will take over from the total processing capacity approximately the proportions shown in table 3.

Table 3

The proportion of capacity represented by the minicomputers

%

1970—1980	1980—1990	1990—2000
2	10	30

IV. the cost of the minicomputers is low and it can be permanently reduced so that the corresponding financial effort is practically a value much lower to that corresponding to the electronic computers. (Hypotheses I and II have been formulated for estimating the maximum value of the equipment effort).

On the basis of the above hypotheses, the curves in Fig. 4 have been calculated, and respectively, the values in table 4.

Table 4

The value of the accumulated equipment effort

thousand million lei currency

Speed of the basic electronic computer (MOS)	1975	1980	1990	2000
0.2	0.9	3	27	210
2	0.15	0.4	3.6	28
20	0.03	0.1	0.9	7

These values suggest the necessity of the utilization of large computing capacities, respectively, of big capacity computing systems. As a rule of orientation, the typical computer considered for the national edp equipment should be characterized by a tenfold increase of speed from a decade to another; otherwise the necessary economic effort cannot be practically made by the national economy. It results that even in the present stage, the design of big capacity systems with multiple access represents an urgent objective.

The inferior limit of the effort is obtained by considering the effect of technical progress, through a relation of the form:

$$C \simeq 10^6 vp \tag{1}$$

where:

C — total working costs (thousand million lei currency)
v — computing capacity (MOS)
p — average cost per operation ($/MO)

The evolution of the average cost per operation is estimated in certain prognosis studies (e.g. [5]). It has also to be taken into account that usually such prognosis studies refer to peak achievements, so that the curve finaly taken into consideration has been shifted three years backward. Results are shown in Fig. 5 and table 5.

Assuming that the average life of a family of computer system is approximatelly five years, the minimum value of equipment in table 6 (compare

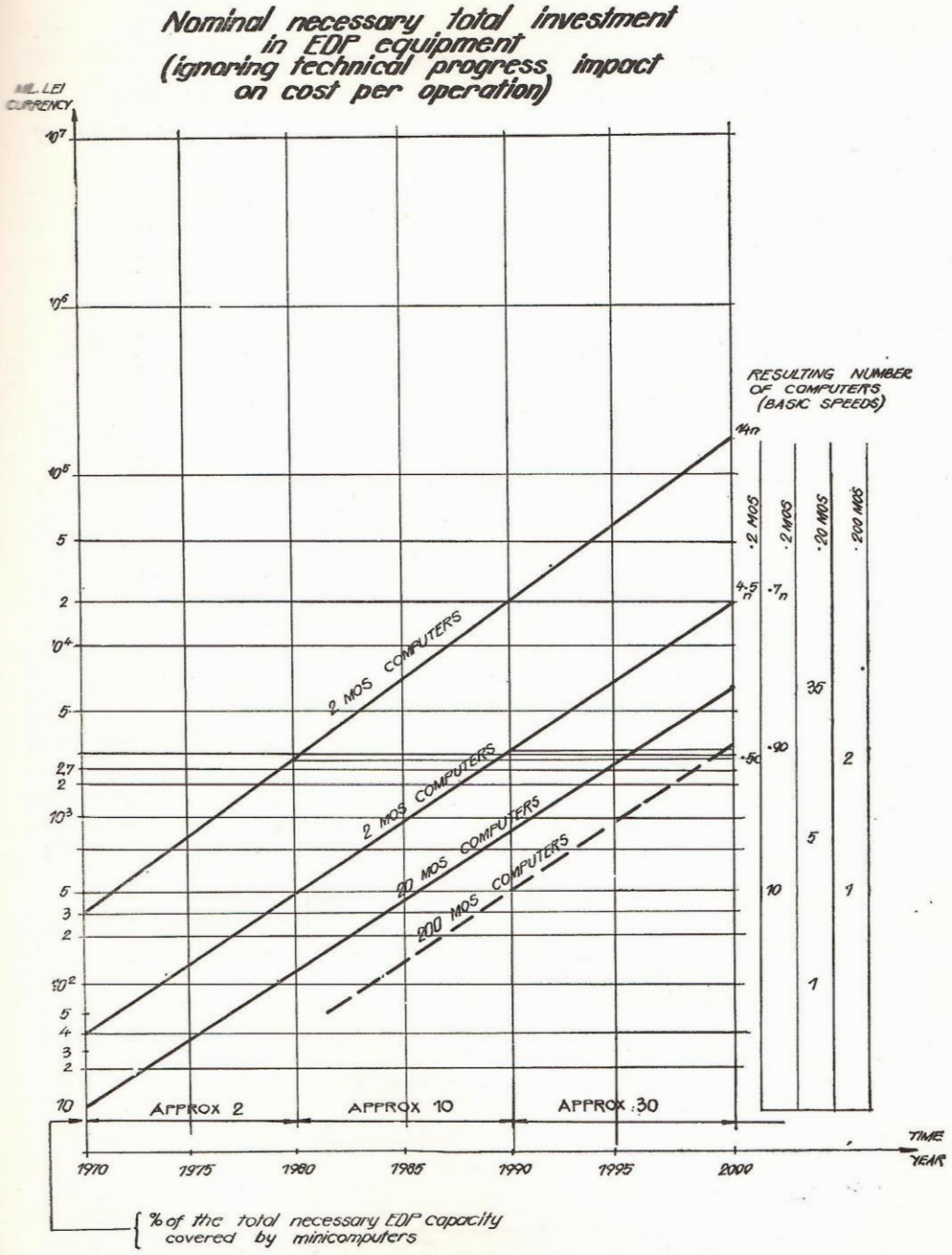
Nominal necessary total investment in EDP equipment (ignoring technical progress impact on cost per operation)
MIL. LEI CURRENCY
RESULTING NUMBER OF COMPUTERS (BASIC SPEEDS)
2 MOS COMPUTERS
2 MOS COMPUTERS
20 MOS COMPUTERS
200 MOS COMPUTERS
APPROX 2
APPROX 10
APPROX 30
TIME YEAR
1970
1975
1980
1985
1990
1995
2000
% of the total necessary EDP capacity covered by minicomputers

Fig. 4

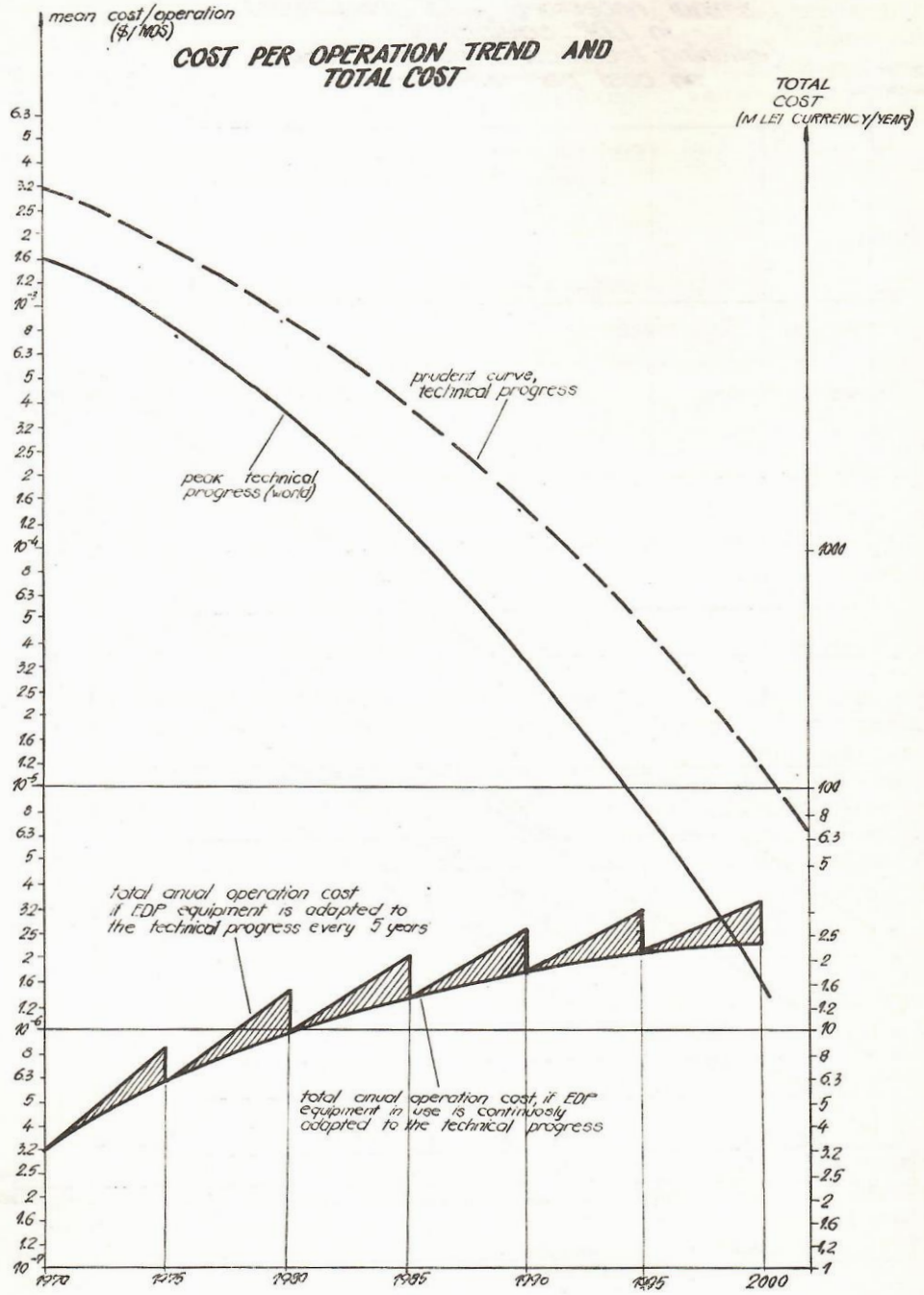
mean cost/operation ($/MOS)
COST PER OPERATION TREND AND TOTAL COST
TOTAL COST (M LEI CURRENCY/YEAR)
prudent curve, technical progress
peak technical progress (world)
total anual operation cost if EDP equipment is adapted to the technical progress every 5 years
total anual operation cost if EDP equipment in use is continously adapted to the technical progress
1970
1975
1980
1985
1990
1995
2000

Fig. 5

Table 5

The value of the annual working costs in the hypothesis of a continuous adaptation to technical progress

MO = million operations
MLV = million lei currency

year	* v(about) MOS	p (about)	10^3\$/MO	c(MLV)
1975	32	1.8		6
1980	100	0.9		9
1990	1 000	0.16		16
1995	3 200	0.07		21

* the correction of the capacity taken over by the minicomputers was not introduced.

it with table 4) would result. The results given in table 6 are represented also in Fig. 4 — the curve "equipment at a maximum technical level".

It results that in the field of electronic data processing, the additional cost involved by the neglection of the most modern solutions, insignificant for a short time, may lead to considerable values for a longer period of time and especially for the period after 1980.

The minimum values, however, do not necessarily represent a realistic objective. Admitting that new equipment can be foreseen every five years and that the practical life of the equipment is of about 10 years, a minimum

Table 6

The minimum value of the accumulated equipment effort

thousand million lei currency

1975	1980	1990	2000
0.03	0.045	0.08	about 0.3

accumulated value of equipment with electronic computers of the order of 1.5 —3 thousand million lei currency results for the 1970—2000 period. It is important to observe that the adaptation to technical progress has the advantage to lead to a much slower increase of the economic effort.

The authors want to emphasize particularly this aspect: taking into account the extremely rapid technical progress, characteristic of the electronic computing technology, the possibility exists not only of achieving the necessary capacity of electronic data processing at a much lower cost than that which would correspond to maintain into operation an obsolete technology, but, also to control the total cost so that it should not be a difficult task for the national economy. In essence, the point in question is about the utilization of the empiric rule which affirms that the average computing speed of the electronic computers increases tenfold every ten years, and the cost is growing in a much more reduced proportion.

This conclusion raises some further problems, such as:

a) the minimum admissible level of integration of home production. In the hypothesis that a main objective would be to reduce the import of electronic data processing systems, it easily results that the average level of integration in manufacturing a complex medium system (including the peripherals) should attain values of the order of 85% (1975) — 95% (1980). This requires the organization of a very powerful industry of computers which should employ several tens of thousands of workers, or the orientation of home production based on foreign co-operation

b) the evolution of research and development effort necessary in the hypothesis of the development of a competitive industry of electronic computers, can be estimated if we start from the value allocated in the 1971—1975 period within the French "plan calcul" (of the order of 1500 MLV) [8] and considering that the volume of funds affected for research and development will increase at a rate at which the average costs per operation will decrease. A value of about 60 thousand million lei currency for the 1976—2000 period is thus obtained. This would imply the value of a cumulated production of the order of 400 thousand million lei currency (at the level of the year 2000), which should be evidently oriented with priority on export.

It results that the development of the production of electronic computers in our country must be analysed on a long term, on the basis of a large number of possible variants. This study does not propose to thoroughly examine this aspect, but only to stress the necessity of a deeper analysis of some fundamental problems. In the authors' opinion, it is imperatively necessary to consider the electronic computers industry as a basic brach of industry and to develop it in cooperation with similar industries in othanr countries, so that the necessary effort for research and development and for production should remain in admissible limits, at the same time, ensuring a cycle of technical progress every five years, thus, a sufficient degree of competitiveness.

4.2. Estimating the necessary personnel

The estimation of the necessary personnel for the necessary capacity of electronic data processing can be affected by entirely new technologies (for example, the advent of systems with artificial intelligence). It was admitted that such hypotheses are still unrealistic until the year 2000. The limitation of the potential of staff, affected by elements of various kinds (the intensification of mechanization and automation in general, the standardization of solutions, the influence of the development of other branches of

economy, the increase in the level of theoretical and practical knowledge in the educational process, etc.) can also be taken into consideration.

The following hypotheses were admitted for the calculation:

a) the staff necessary for the computer industry (production and maintenance) can be ensured by the national society, because:

— it represents a relatively very small proportion of the active population (of the size order of tens of thousands);

— partially, it does not require a very specific training (for example, an important part of the computing system production is represented by fine mechanics and electronics);

b) the necessary staff for operating the systems ensured, raising no special problems of training;

c) the staff necessary to use the equipment, namely for writing programmes for various application or directly associated with the automated data processing systems will be provided through recycling and the general growth of technical culture, as part of which the electronic computer is ever more assuming the role of a usual work instrument;

d) an estimation is justified only for highly trained analysts and programmers necessary at each computing centre, and for highly qualified analysts and programmers necessary for the development of library programme systems.

A decrease of specific staff with the processing capacity and in time has been considered possible due to:

— the better use of the staff on concentrated capacities;

— the development of a standard programme library;

— the increasing use of multiple access.

The curves for the increase of the necessary staff are given in Fig. 6, which leads to the conclusion that, in the hypothesis of a gradual equipment with big capacity computers and of a limited increase of the higher education output, the necessary staff can be ensured. In the hypothesis that the equipment policy is not adapted to technical progress, an important deficit of specialized staff will appear, which is difficult to ensure even if the output of higher education would increase by an order of magnitude.

For the second category, the estimations can be only rough. Admitting that the effort should be oriented at least to: one operating system, one utility programme system and 20—30 standard application systems, a minimum necessary 500 man years results. The achievement of these objectives during a cycle of technical progress represents a minimum value of 200—300 highly skilled specialists.

As their cycle of training is long, this result is expected to represent the main practical limitation. Therefore, some measures appear as extremely important, such as:

— the adaptation of the planning of education to the option taken as regards the equipment and a considerable intensification of the link between education and practice in the field of the using and manufacturing of computing equipment;

— the ensurance, as much as possible, of the software library systems by cooperation with various partners.

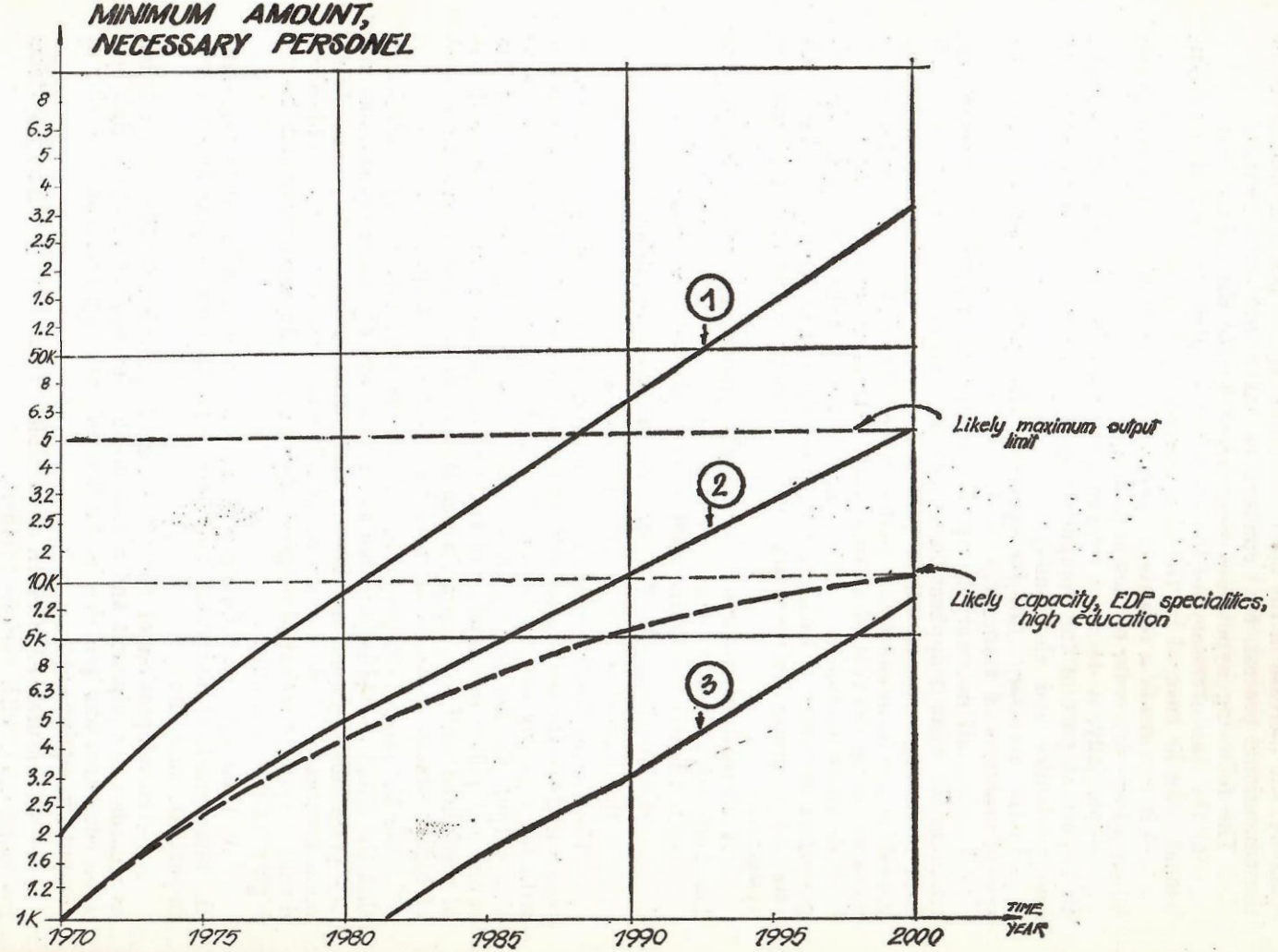
MINIMUM AMOUNT,
NECESSARY PERSONEL
8
6.3
5
4
3.2
2.5
2
1.6
1.2
50K
8
6.3
5
4
3.2
2.5
2
10K
1.2
5K
8
6.3
5
4
3.2
2.5
2
1.6
1.2
1K
1970
1975
1980
1985
1990
1995
2000
TIME
YEAR
1
2
3
Likely maximum output limit
Likely capacity, EDF specialities, high education

Fig. 6

— the ensurance of the condition that the electronic equipment in a period is compatible (at least downwards) with the equipment in the following period, in other words, equipment should be based, as much as possible, on long range and unitary series policies.

Informative values of the evolution of the necessary specialized staff in the field of the use of computing technique are given in table 7.

Table 7

Estimated evolution of the minimum necessary specialized staff for using the data processing system

order of magnitude = thousands

	1980			1990		
Variant (MOS)	0.2	2	20	0.2	2	20
Highly qualified analysts and programmers	4.5—10	1.5—3	—	25—50	5—10	1—2
Other analysts and programmers	9	5	—	90	45	4.5
Operators	7.5	1	—	65	9	1.8

* * *

The prognosis of the long-term development of the electronic data processing potential in our country has raised, in the first place, the problem of choosing some simple and synthetic indicators, for which prognoses exist and that of estimating some orders of magnitude. The definition of the processing capacity by the computing speed is, of course liable to criticism especially if real systems and applications are taken into consideration. The clear tendencies concerning the increase of speed and the significant correlation with the average cost of the electronic data processing systems are sufficient arguments for estimating the orders of magnitude; of course, this does not exclude deeper analyses which must imply much thorougher prognoses in the field of technology, surpassing by far the framework of this study.

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PROBLEME DE LA PREVISION DE L'EVOLUTION A LONG TERME DU POTENTIEL DE TRAITEMENT ELECTRONIQUE DES INFORMATIONS EN REPUBLIQUE SOCIALISTE DE ROUMANIE

Le présent travail constitue un essai d'étudier les tendances d'évolution à long terme de la technique de calcul en Roumanie.

L'ouvrage porte tout spécialement sur l'aspect de la technologie d'utilisation de la technique de calcul et vise à donner la définition de certaines limites probables. De même, on suggère quelques unes des grandes options à faire dans un avenir pas trop éloigné.

ВОПРОС ДОЛГОСРОЧНОГО ПРОГНОЗИРОВАНИЯ РАЗВИТИЯ ПОТЕНЦИАЛА ЭЛЕКТРОННОЙ ОБРАБОТКИ ИНФОРМАЦИИ В СОЦИАЛИСТИЧЕСКОЙ РЕСПУБЛИКЕ РУМЫНИИ

Настоящая статья представляет собой попытку анализа тенденций долгосрочного развития вычислительной техники в нашей стране.

Она направлена, в особенности, на аспект технологии использования вычислительных машин и преследует цель определить вероятные пределы, а также предложить некоторые основные решения, которые необходимо будет принять в не очень отдаленном будущем.

6.V.1973