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Long-term Planning

by

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"Opinions Expressed and Positions Taken by Authors are Entirely their Own and do not Necessarily Reflext the Views of the Institute of National Planning".

Contents

1. Introductionary remarks dealing with basic questions of long-term planning.

In the GDR prospective planning becomes more and more a main instrument of economic leadership. The growing importance of longterm scientific forecasting is caused by the increasing dynamic of social processes, in economic fields for instance caused by the scientific-technical revolution just underway. Successful prospective planning is based upon the recognition of social-economic laws which exist objectively. Hence the social aim of the longterm economic development is determined by the existing social system and its adequate economic basic law. In our case it is the satisfaction of the population's needs in material, cultural, etc. aspects so far as possible under the given conditions. The quantitative expression of this aim is the maximum growth of the material volume of the available national income per capita. The longer the planning period the more important is the determination of optimum consumption targets, whilst for instance annual planning might take the consumption structure nearly as constant and stressing the minimization of expenditures, which are required to realize the production programme.

In order to achieve and to safeguard the reality and applicability of longterm plans prognostication, planning, and actual management must be seen as a unified complex based upon public ownership of economic key positions, centralized and nationalized information functions, and the codetermination as well as cooperation of the masses of the people. We have to avoid that prospective plans are pure and abstract models and calculations.

An economic prognosis might be defined as a scientific-based forecasting regarding future economic events and processes. Starting from the social needs, social economic laws, and the development trends of science and technology prognostic models are the foundation of prospective plans. Determinating the essence of economic prognosis we consider the following points:

- Prognostication and planning form a unity, but they are not identical.
- In order to grasp the economy in its complexity the construction of models is necessary.
- The character of prognostic models is not a passive but an active one. We assume the possibility to influence future developments actively.
- Prognostic models are stochastic models, their conclusions have a probability character.
- Prognostic models include the analysis of the past, the present, and the future. All prognostic methods can only be based upon actual knowledge.
- Prognostic models require permanent progressive as well as retrogressive calculations in order to set up and to secure the connection between the existing conditions and the requirements of future periods.

In general reality and certainty of prospective models depend on the length of the forecasting period. The longer the analised time period, the higher the uncertainty of prognostications. The prognostic horizon differs in accordance with the various aims, scopes, purposes, etc. of the projections. Longterm partial projections may cover a period of 30 or even 40 years, complexe prognostication between 15 and 30 years, and the more detailled prospective plans 5 or 7 years.

In the G.D.R. prospective plans become more and more main instruments of economic leadership. Prospective planning is based upon

- analysis of the economic resources and possibilities, including the analysis of the fulfilment of the actual plans;
- prognostications regarding the scientific and technological development, the economic future, and the further progression of education, vocational training, etc.;
- determination of scientific normatives and standards regarding material consumption; effectivity of capital funds, etc. including forecastings about their future development;
- results of balancing in national as well as international scale considering the prognosis of coordination and cooperation with other countries.

All those elements of prognostic planning are shaped as pyramids, although this is not a problem of simple aggregation. At the top of the "pyramid" we find the development prognosis of the entire economy, elaborated by the State Planning Commission in cooperation with the State Secretary of Research and Technique, the Research Council, the Ministries, and the Academies. The development prognosis consists of

- longterm calculations of development and structure of gross production, national income, accumulation and consumption, based upon trend calculation regarding the growth of population, employment, fixed assets, and labour productivity;
- main proportions and directions of research work;
- development of the educational system;
- estimations of the industrial structure (profile) as well as the structure of foreign trade;
- projections of the raw material sources.

In this stage of longterm planning first and rough optimation take place. Parallel and coordinated with the elaboration of the total development prognosis a series of branch projections are worked out. Based on these approaches it is possible to complete the socalled longterm development conception of the economy as a medium step between prognosis and plan. This conception is characterized by a higher level of balancing and optimation; the facts are more detailled, such as the directions of investment policy, the development of prices, wages, living standard, etc.

To work out development conceptions regarding branches and enterprises cannot be a simple disaggregation of the total conception. In the given frame of only a few but very decisive indicators aimed to safeguard main proportions the branch organizations and the enterprises - at least large and leading enterprises - have to work out their own prognosis and development conceptions. On enterprise and branch level some additional problems come into the foreground, such as the amount and the turn over time of the various assortments; the possibility to substitute products, the dispon/ibility of the different productive elements, the position of the branch or any a partial system in the frame of the total reproduction process.

The following sketch 1 may summarize the system of prospective planning in a simplified manner in the G.D.R. :[1]

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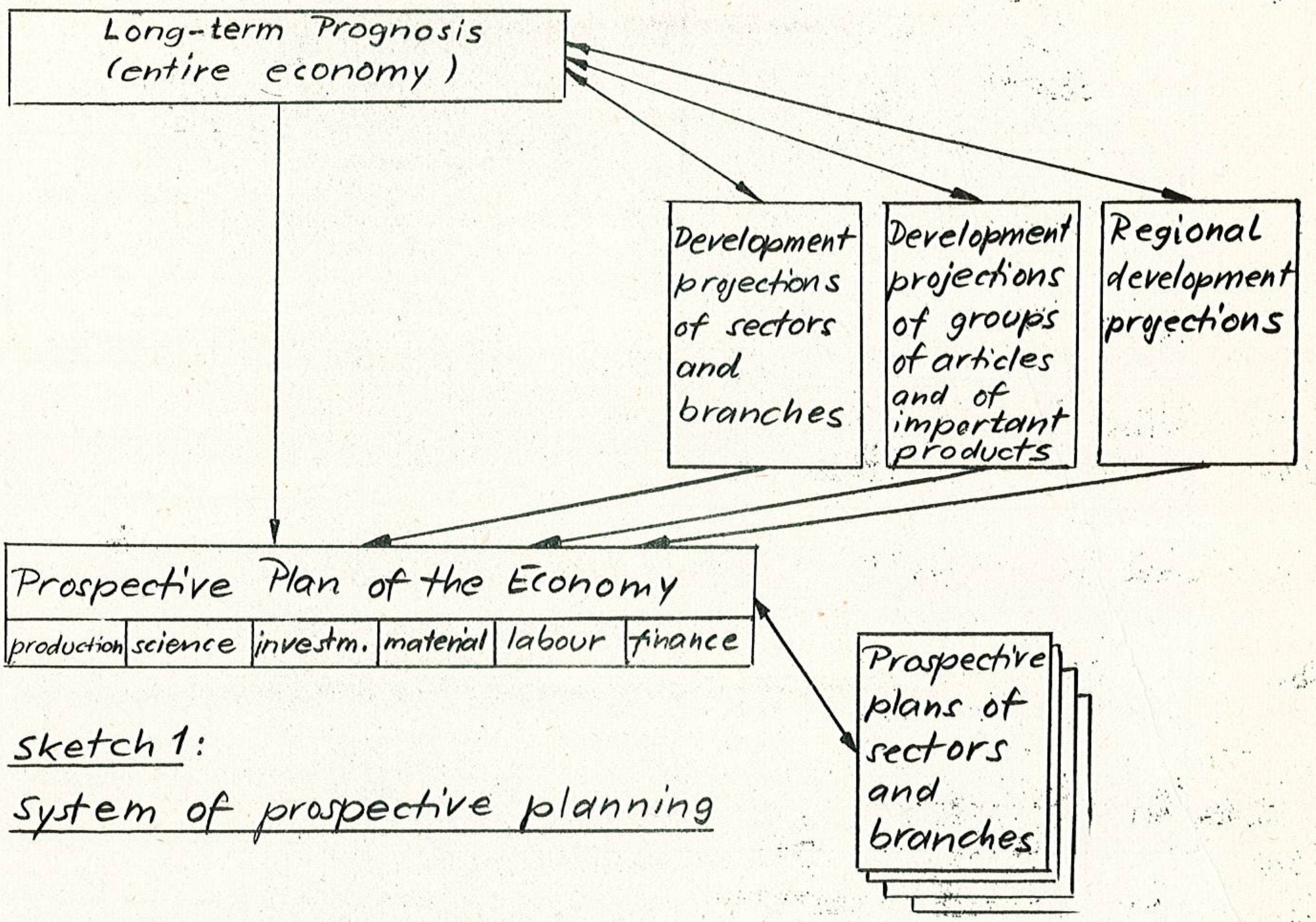
1) cf. "Betriebs ökonomik Jndustrie", part I, p. 99; Berlin 1967.



Sketch 1:
System of prospective planning

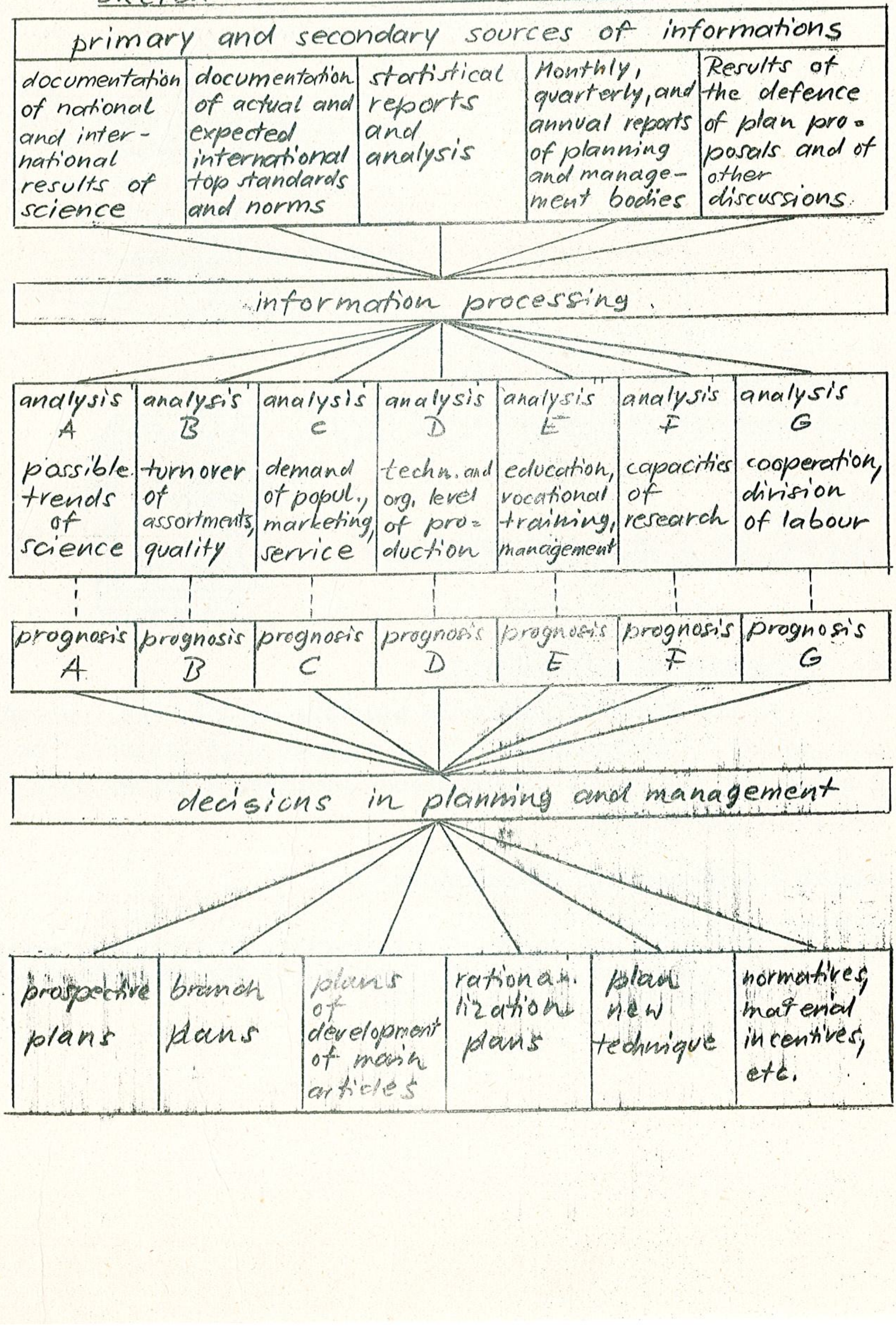
2. Obtainment of informations.

In the field of long-term planning amount, age, contents, and quality of informations are of highest significance. Sketch 2 shows the sources of informations and gives a survey upon information processing.

Sketch 2 : Sources of Informations 1)

1) cf. Haustein, in, Socialist Management of Industry, textbook for extra-mural students, edited by the Economic University Berlin 1966, part 2, p. 80.

Sketch 2: Sources of Informations



In the G.D.R. we are going to classify prognostic information regarding their quality. A numerical valuation scale from 0 to 1 was proposed. The criteria of valuation and classification are :

A. To what extent does the information contribute to improve our knowledge about relatively stable economic relations in form of statistics, regression functions, constant factors, etc. ?

B. To what extent does the information give us references regarding the future behaviour and strategy of the relevant environment of our system ?

C. To what extent is the information a result of specific processes (research etc.) inside the own system including the possibility to come to new findings and ideas unknown outside the system ?

The following table 1 makes an attempt to show how to valuate informations with the aid of the mentioned three criteria. The column "examples" serves only as an illustration, so for instance doctor thesis can appear in the first as well as the fourth group.

Table 1 : Valuation of Informations[1)]

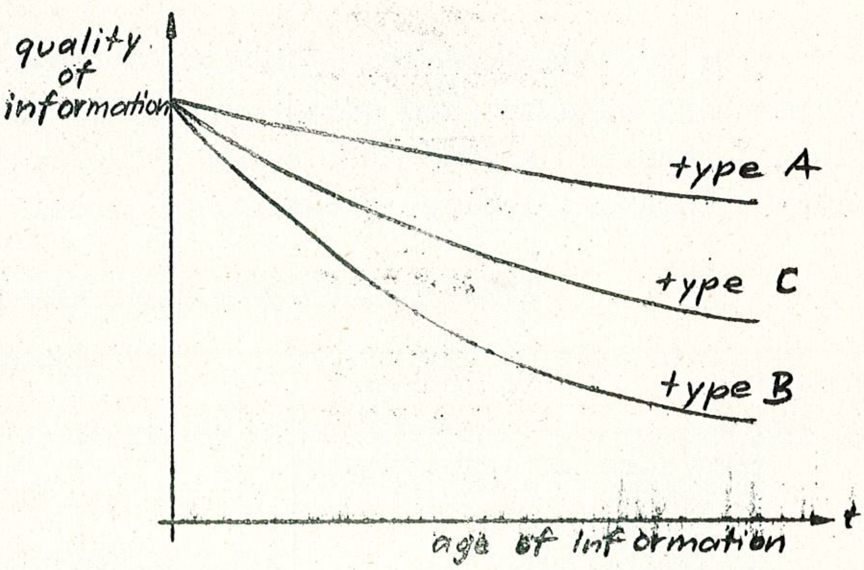
groups	examples	criteria A	criteria B	criteria C	valuation
1	articles of competitors, patents, catalogues, inquires, etc.	slight	medium	none	0.20-0.39
2	internal materials of the competitors, periodicals, contracts, doctor thesis, etc.	medium	great	slight	0.30-0.59
3	special books, literature about results of research work	medium	medium	great	0.60-0.79
4	scientific findings	great	slight	great	0.80-0.99

1) cf., l.c. p. 75.

In practice the analysis of informations' quality combines this valuation with the criteria of time, i.e., <u>the age structure</u> of the informations. We can classify the sources of informations in

1. Informations with a great loss of time (more than 2.5 years). such as special books, articles of the competitors;
2. Informations with a medium loss of time (about 1.5 years), such as periodicals, fairs, catalogues;
3. Informations with a slight loss of time (less than 1 year), such as discussions, conferences, cooperation. [1]

In general the value of an information decreases with its growing age, but the behaviour of different kinds of informations differs, as represented by sketch 3 :



<u>Sketch 3:</u>

Relation between quality and age of information

1) cf. : Ardenne, Wege zur Steigerung der Welt-marktfähigkeit unserer industriellen Erzeugnisse, Berlin 1963, p. 59.

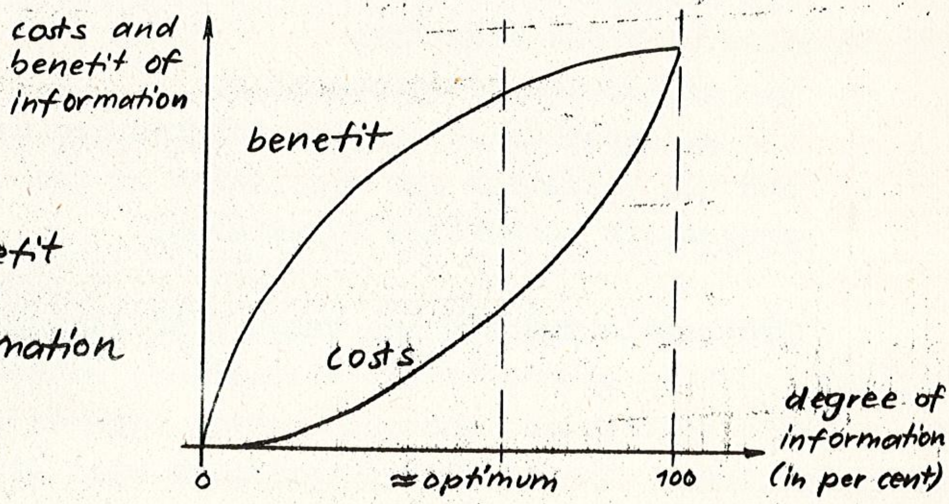
In sketch 3 the types A, B, and C are in accordance with the criteria of table 1. That means informations in form of statistics, coefficients, etc. are of relatively invariant quality with growing age, whilst the external strategical informations show the most rapid loss of quality.

Besides quality and time factor we have to consider the relation between costs and benefits of informations. It is suitable to avoid superfluous informations as well as a lack of important facts and data, i.e., an optimum relation between actual and necessary informations or an optimum cost-benefit ratio might be achieved. Sketch 4 illustrates this relation under average conditions.

Also in connection with the collection of informations we have to consider the time factor. It is at any rate unefficient to start prognostications to early or to late. The more far away our projection horizon, the more expensive will be our information activity. The possibilities to get informations are the better the nearer the date of the expected event.

Sketch 4:

Costs and benefit related to the degree of information



We can summarize that the basis of prognostic models, conceptions and decisions are

- a suitable and efficient system of information obtainment,
- an effective information processing, and
- a systematic storage of informations. Informations must be collected about
- the demands of the population and the economy, fixed for instance in resolutions and programmes of the government and the leading party,
- the trends of science, technology, etc.,
- the present and future behaviour of the consumers,
- the behaviour of competitors,
- the own conditions and possibilities, such as raw material sources, manpower, etc.,
- the requirements of national and international specialization and division of labour.

3. Prognostic methods and procedures.

The prognostic preparation of planning and decision finding consists of three elements:

- the collection of information,
- the application of special forecasting methods,
- and the voluation and discussion of the results of the prognostic activities by experts.

Prognostic methods are taken from various faculties of science, such as econometrics, statistics, mathematics, cybernetics, etc. Their application and combination depends on the subject of investigations. The projected variables will differ from the point of view wether they are existing in present or they will exist in future, wether they have a development history as a basis of trend calculations or not; some variables are strictly determined by others, some are more or less open to our active influence and other variables not at all.

In accordance with the prevailing circumstances and possibilities prognostic methods are combined to procedures. Some of these procedures are the following.

a) Time series research

The applicability of this method depends on the existence of data regarding the investigated problem. The available data have to cover a more or less long time period. The analysis of the development curve in recent years allows conclusions about the expected further development, at the best we will get a time series which shows us functional dependences representing economic laws. It is a simple and understandable method. The difficulties are:

- a lack of statistical etc. data;
- available data are in many cases not comparable or at least not to a sufficient degree. This is caused by changing definitions and statistical groups, in case of value terms it is caused by changing the prices. Even the calculations with fixed prices must include deviations and distortions.
- It is necessary to eliminate untypical and extreme deviations.
- The most important disadvantage is, that the development in the past in overestimated. It is possible to diminish this disadvantage with the aid of trends weighted in favour of the most up to date data. Another method to improve time series uses margins fixing the permitted deviation of data from the trend. If there are data outside the fixed margins a new trend (and new margins) must be calculated.

Despite these disadvantages and difficulties the time series analysis is a special and a relatively independent prognostic method. We distinguish several stages of its application. The lowest stage and the first approach is the wellknown calculation of trends. The investigation of causalities is reduced to the pure time dependence of the variables. Of course this relation is poorer than the interactions and interrelations in reality, but the time dimension is in any case of highest importance in the field of economic observations and the trend will express to a certain degree the more essential relations. With other words, trends summarize the impact of a lot of factors affecting the dependent variables, but without giving detailled hints regarding the weight and the kind of the causal factors.

To overcome this disadvantage we are bound to use time series in a definite form, i.e. linked up with the real causalities, For example the development of the tool engine demand may be seen as a function of the development of investments in metal processing industries. Usually a set of coefficients have to correct the results.[1)]

Another example: The future demand on bulbs and neon tubes has been calculated as a function of

- necessary replacement of the existing lights,
- development of electroenergy production;

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1) cf. : Bretschneider: The Ascertainment of the Prospective Demand on Tool Engines in order to Determine the Required Volume and Growth Rate of the Production of Tools in G.D.R., Dissertation 1964, Economic University Berlin 1964.

- increase of light requirements and norms,
- increase of luminous effectivity of improved bulbs, fluorescent tubes, etc.
- increase of the durability of lamps;
- development of production area,
- development of number of flats,
- structural changes of the bulb assortment.

This method divides the original aggregate into his determinating components, which must be estimated and extrapolated separately.

Higher stages of time series research use <u>regression function</u>. Regression and correlation analysis consider the stochastic character of economic processes and hence it is possible to get a more exact impression about that what happened in reality. With the aid of this method it is for example possible to analyse whole chains of causalities, such as the interaction of prime cost (Y) - labour productivity (X_1) - development of fixed assets (X_2) - investments (X_3) - research expenditures (X_4) etc.:

$$Y = f_1 (\hat{X}_1)$$
$$\hat{X}_1 = f_2 (\hat{X}_2)$$
$$\hat{X}_2 = f_3 (\hat{X}_3)$$
$$\hat{X}_3 = f_4 (X_4) \quad \text{etc.}$$

If there are temporal intervals between the events, such as between research and investments, than we can conclude from actual data to the future.

A second possibility to apply regression analysis in a more det ailled form consists of the decomposition of an aggregate in order to analyse the specific causes :

$$\hat{Y} = \sum \hat{Y}_i \qquad (i = 1, 2, \ldots, n)$$

$$\hat{Y}_1 = f_1 (\hat{X}_1)$$

$$\hat{Y}_2 = f_2 (\hat{X}_2)$$

$$\vdots$$

$$\hat{Y}_n = f_n (\hat{X}_n) ,$$

with, for example

$\hat{Y}$ = demand on bulbs

$\hat{Y}_1$ = demand on bulbs for flats

$\hat{X}_1$ = population development

$\hat{Y}_2$ = demand on bulbs for industry

$\hat{X}_1$ = industrial production development

$\hat{Y}_3$ = demand on bulbs for street lighting

$\hat{X}_3$ = electroenergy production development, etc.

These methods of simple regression presume systems with single causality relations, respectively the solution of multi causes systems step by step. If we consider the parallel actions of several causes, than we have to use multiple regressions:

$$\hat{Y} = f (\hat{x}_1 \hat{x}_2 \ldots \hat{x}_n)$$

Labour productivity for instance will be determined by a set of factors, such as capital, working time per day, qualification of the workers, etc. Some difficulties will arise if there exists multicollinearity, i.e. if $\hat{x}_1\ \hat{x}_2\ \ldots\ \hat{x}_n$ are intercorrelated. The result can be, that we get no unique solution. Another problem is that of complete interdependence of the entire system, i.e. also the dependent variable acts back on the set of explanatory variables.[1)]

It is not necessary that economic managers know the theory of time series in detail, but they must be able to use the results. Trends are very important indicators representing the most essential development directions, showing the influence of strategical factors, and the possibilities to take decisions and to act in a proper way. They are a more reliable instrument of economic leadership than personal opinions or reports of the enterprises etc.

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1) For details on multicollinearity, see

1 - R. Frisch, Statistical Confluence Analysis by Means of Complete Regression Systems, Oslo 1934.

2 - T. Haavelmo, Remarks on Frisch's Confluence Analysis and Its Use in Econometrics, chap 5, p. 260, in T. Koopmans (ed.), Statistical Inference in Dynamic Economic Models, New York 1950.

3 - J. Johnston, Econometric Methods, Mc Graw-Hill Book Company, Inc., New York, San Francisco, Toronto, London. International Student Edition Tokyo 1963.

b) Structural research

Very often economists are confronted by the fact, that there are no time-series data available. Under this condition we have the opportunity to use cross sections of economic conditions at a fixed date as a starting point of prognostic conclussions. We would like to name these procedures structural research. Structural research uses various analytical and prognostic methods, such as comparisons and also regression analysis.

As an example of structural research we will take the problem of quality costs, i.e. the expenditures of enterprises aimed to improve [1] the quality of their products. As we know the conditions created by the technical revolution call for a considerable enhancement of the quality of industrial products. Besides this quality costs come to a considerable share of the total prime cost. For the correct policy with regard to, and the planning of, quality in industry, it is essential to calculate the optimum variant of raising the quality level.

Besides the expenditures to develop quality there are expenditures aimed to safeguard the quality of current production, such as costs in order to prevent rejections and to reduce the production of defected goods, i.e. <u>prevention costs</u> (including test costs), and, on the other hand, costs created by rejections, such as the fulfilment of guarantees, i.e., <u>failure costs.</u>

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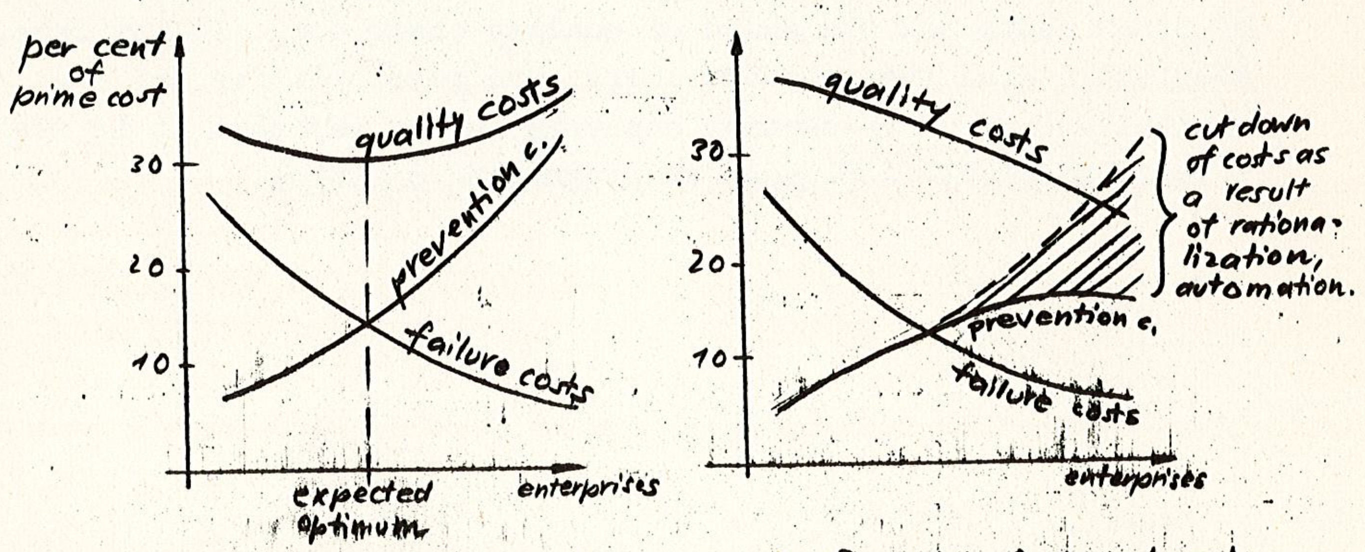
1) See : Haustein, Technical Revolution and Quality Costs, in "Wirtschaftswissenschaft" 11/1965; p.1832.

In connection with the elaboration of their master papers students of the Economic University Berlin collected and prepared the necessary structure data in enterprises, branch organizations, and added international comparison figures. The cross-section comparison has had the aim to get informations about development trends of the structure of quality costs. One of the specified questions was to verify the thesis, that decreasing failure costs must be connected with increasing prevention costs. The investigated enterprises were ranked in accordance with their different shares of failure costs. The following sketch 5 shows the result of the structural research compared with the hypothetical development scheme, which expected a certain optimum relation between prevention and failure costs.

<u>Sketch 5:</u> Quality cost structure comparison



5a: Hypothetical scheme

5b: Result of structural research

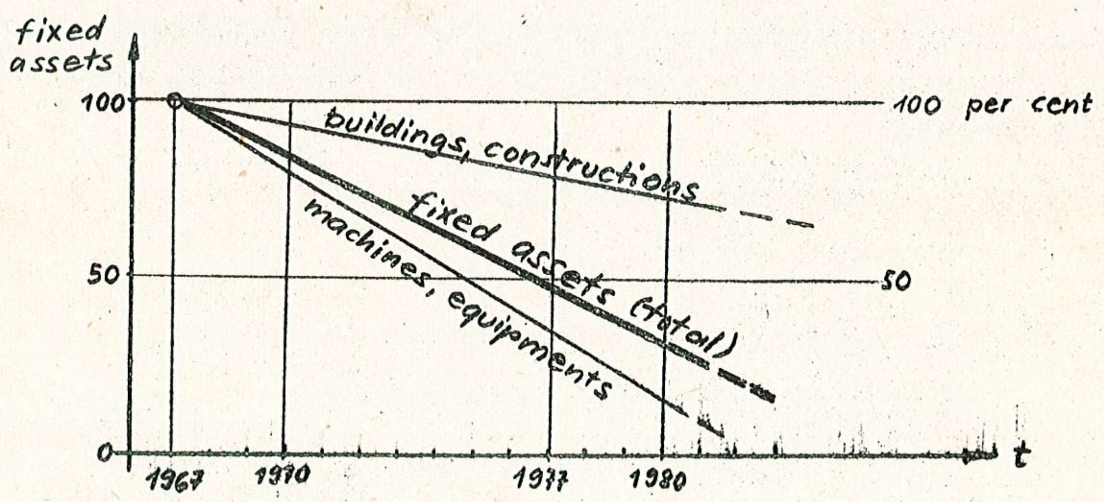
The result was to some extent surprising . Prevention costs will increase as a precondition to decrease failure costs only during a first stage of development, later on prevention costs will also decrease as a result of rationalization and improvement of all the measures and activities carried out in order to secure the quality of the articles.

It is impossible to mention all the difficulties and the further steps necessary to get sufficient and reliable results. In our case a set of detail investigations in enterprises were necessary , the cross-section analysis was completed by time-series calculation for each enterprise showing the development of prime costs and the share of quality costs etc. At any rate, keeping in mind the pros and cons, the possibilities and the limitations of cross-section analysis, we can say that it is really a very important instrument of prognostic planning.

c) Analysis of invariances

Whereas the mentioned procedures try to determine the temporal variance of parameters, this procedure is orientated to analyse relatively invariant relations. To give an example : One of the most trustworthy prognostic calculations is that of the replacement of outdated and depreciated fixed assets. The precondition is a structural analysis gaining facts about the age and the degree of wear and tear of buildings and equipments . Assuming that new machines may be used in average for a period of ten years we will get relatively trustworthy figures about the necessary replacement expenditures for the following ten years. Of course the prognosis must be more or less disaggregated, at least into constructions and buildings on the one hand and machines and equipments on the other hand. Simplified the result may look like the following sketch 6 :

Sketch 6: Expected replacement of fixed assets.



Though we will never find absolutely invariant relations it is possible to calculate with a series of constant coefficients, especially in highly aggregated models. To a certain degree deviations can be neglected. For the time of prospective plans we can assume a nearly constant population growth rate. Or, for example, if we have a sufficient prognosis concerning the development of the number of motor cars, than it is not very difficult to calculate figures about the consumption of fuel for cars with a sufficient degree of exactness. Many technical parameters are for a certain period nearly constant, so for instance the relation between volume of buildings and the needed concrete.

To add a further example : The structure of family budgets are characterized by a certain invariance. The share of expenditures for clothing e.g. has been estimated in France for the year 1985 with 10 per cent, compared with 12.2 per cent 1960 and 13.3 per cent 1950. Based on the same indicator method Kneschaurek calculated the following regression function concerning individual consumption and clothing expenditures for the period from 1927 to 1940 in the USA:[1])

$$X_1 = -42,2 + 27 \log X_2$$

$$X_2 = 11.3 + 0.63 X_3$$

with X_1 = expenditures for clothing and shoes,

X_2 = total individual consumption

X_3 = brutto social product (in milliard Dollars)

A comparison with actual figures verified the function to a sufficient degree, the deviation of the 1957 X_1 figure for

1) Kneschaurek, Probleme der langfristigen Marktprognose, Aussenwirtschaft 1959/15, p. 321, St. Gallen.

example deviates by about 11 per cent despite the nearly 20 years distance, that means the prognosted figure is higher than the real clothing expenditure share. The prognosted X_2, total individual consumption, is nearly exact.

Despite these results we have to keep in mind that the above mentioned function is based upon actual figures. The main problems arise if we are going to forecast the development, in particular the growth of X_3, the gross social product, esp. under the conditions of an unplanned economic system. Secondly there is a long way to usable conclusions concerning the production programmes of the various textile branches. But the value of invariance research should not be underestimated. Invariant relations are preconditions of trustworth y trend calculations.

d) Input-output analysis:

Highly aggregated interlacement balanced are relatively invariant and hence they are an instrument of prognostications. At any rate the final demand must be estimated applying other methods. Input-output analysis is in so far of importance in the fields of prognostic planning, as it is possible to predict not only the direct but also the indirect inputs, i.e. one important side of economic interdependence. The more disaggregated the model, the more difficulties arise.

A special problem in this connection is the prognostic calculation of the technical coefficients. The reliability of prognostic input-output models depends on the exactness of the coefficients projection. Contents of the planning of coefficients is the planning of energy and material consumption, aimed to economize the use of these raw materials.

Planning of technical coefficients is based upon the material consumption normatives used in the enterprises and branches, and there exist a close connection to planning of scientific technical progress, investments, and labour productivity.

In accordance with the innportance of coefficients development planning it seems to be suitable to explain the procedure more in detail.[1] The following problems must be solved:

1. Analysis of the <u>structure of the technical coefficients.</u> We have to know which kinds of products and which kinds of raw material are aggregated and their share in the aggregated coefficient. This is a precondition to recognize the factors affecting the coefficients and hence to plan their development. On all levels of planning and management the influence of changing production programmes as well as of altering material consumption standards, i.e. of elementary technical coefficients on enterprise level, on the development of the aggregated coefficients must be estimated and planned.

2. Analysis of the <u>functional dependence of material consumption on the production development.</u> We have to quantify which parts of material consumption will remain constant, which parts will be in a linear, and which in a degressive or progressive (non-linear) relation to the increase of production. Besides this other kinds of relationship should be considered, such as the relation between material consumption and machine hours , employed workers, etc.

   Material - and energy consumption can be constant, i.e. independent on the growth of production, e.g. in form of
   - heating and lighting of the buildings,
   - certain auxiliary - and repair materials,
   - energy - and material consumption of managerial institutions,
   - materials for labour protection , etc.

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1) cf. Pieplow (Econ. Uni.Berlin), Planning of Technical Coefficients, article in " Planning and Management", Part I, Input-output Analysis in Partial Systems, Berlin 1965, PP. 129-177.

The soviet economist Eidelman calculated some constant input shares, such as in coal industry 10.4 per cent and in electro energy production even 26.7 per cent. The amount of these shares shows how important it is to eliminated these constant inputs, to combine them in a special vector, which can be added to obtain at least total inputs.

A development of material inputs in a proportional way to production growth can appear, if there are

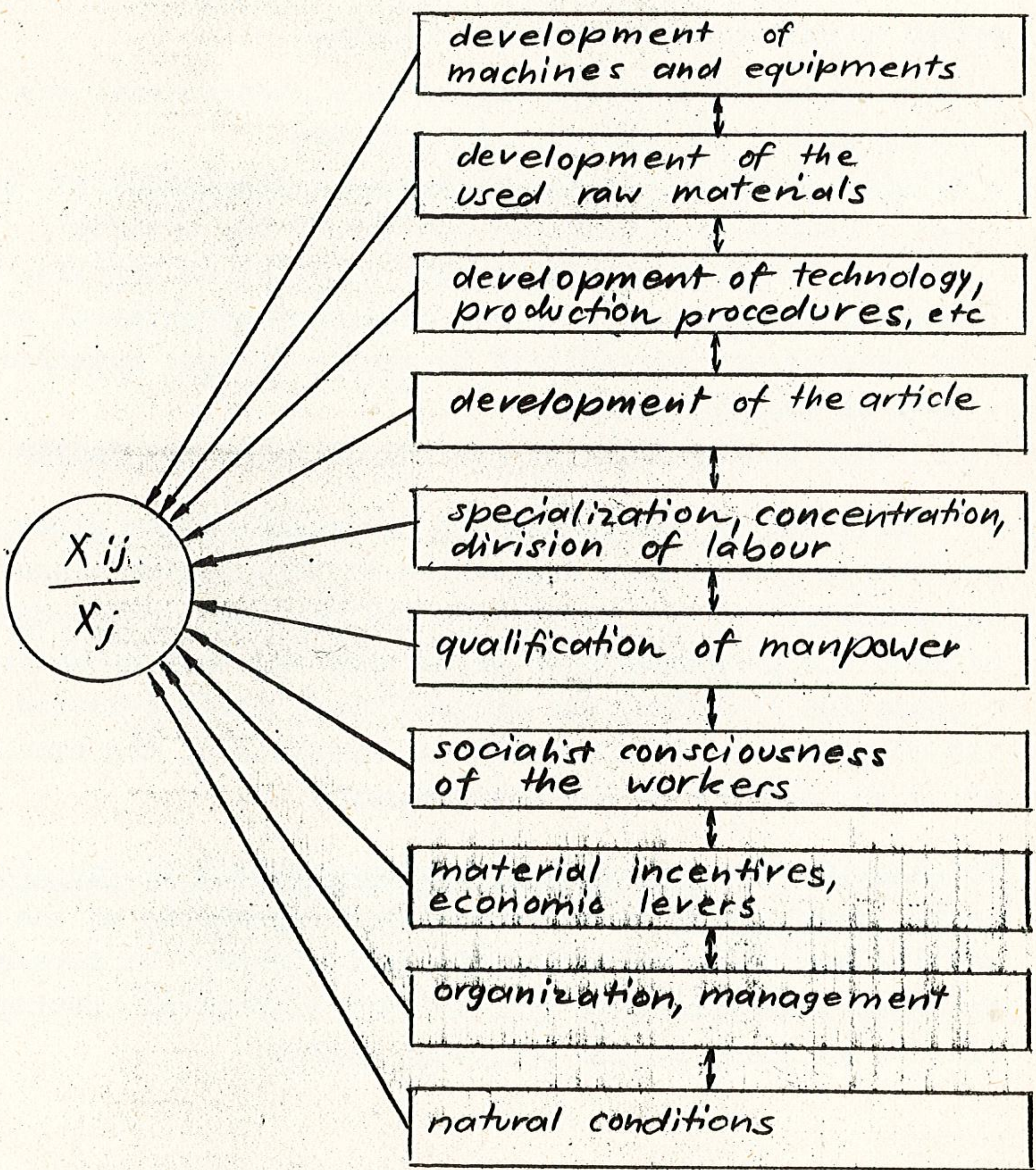
- binding recipes, e.g. in chemical or pharmaceutical industries , caused by a required quality of the articles. This is also the case regarding many articles of textile, foodstuff , metallurgical -, and construction material production,
- no chances and necessities to change design, construction, etc. of any an article;
- no other alternatives to use the existing equipments.

At least we should analyse the coefficients altering with production growth in a degressive or progressive manner. The determination of the alteration can be based upon comparisons between the progression of production and that of material consumption including the projection of their relation for future periods. This requires an analysis of the factors affeting the changes of the coefficients.

3. To quantify the <u>influence of various factors on the coefficients development</u> is a precondition especially of the projection and prognostication of coefficients. In several branches classification systems were elaborated listing the factors as shown in the following scheme:

Sketch 7:

Factors affecting
technical coefficients



Of course the factors or groups of factors are interrelated. Normally changes of the coefficients are caused by a whole series of causalities, such as the chain economic incentives - socialist consciousness - qualification of the employees - organization and management of production - quality of the articles. A large variety of combinations is possible. It is impossible to find a valuation of the factors with general validity. At any rate technical progress is the decisive factor. The factors must be weighted in accordance with the different conditions of the branches.

4. Based upon the analysed structure, development, and influencing factors of coefficients we can attempt to solve the main problem: The elaboration of suitable procedures to determine the exact magnitude of the coefficients and their validity in future periods. So the alteration of coefficients depends on structural changes of production, on technical progress, on the increase of labour productivity, etc., it is necessary to plan the coefficients step by step in a parallel way to the stages of the process of entire prospective planning. The same comes true in regard of the application and step by step improvement of prognostic input-output models at all.

The first step comprehends the prognostication of the main directions of science and technology, based upon adequal branch development programmes and scientific - technological conceptions regarding the development of main articles or article groups. In this stage it will be determined, wether and which new articles, materials, procedures , etc. will be introduced, the date of introduction , and the expected effect on the structure of the whole reproduction process including the changes of the interlacement coefficients.

In prospective planning we have to deal at least with the following indicators from the very beginning:

1. Expected magnitude and structure of the demand, the needs of production and consumption,
2. The necessary capacities and investments to cover the needs,
3. The expected consumption of energy and material per unit of the most important articles, and
4. The necessary and possible labour input per production unit.

Planning of coefficient development and the calculation of variants with the aid of input-output analysis is based upon these main indicators. Projection of coefficients is concentrated on the determinating coefficients. These coefficients are aggregated to a certain degree. It seems to be suitable to plan the coefficients on branch level, implemented by the research centres attached to the branch organization. These centres are in charge of the documentation and analysis of the results of international science in the related fields. We delegate the function of coefficient projection to these institutions because we expect the highest possible concentration of special knowledge and experiences there, and therefore the highest possible degree of exactness achieved in prognostications.

In the further stages the input-output tables must be improved permanently, and, going more and more into details, a set of partial models will be elaborated. During the implementation of the plans it is of outstanding importance to observe all deviations of the development of the planned coefficients from the actual ones, to analyse the reasons, and to come to proper corrections and conclusions.

c) Analysis of marginal values.

The determination of saturation degrees and limits is in a certain sense an autonomous way to forecast further development trends. Marginal coefficients exist in techniques as well as in the economy, such as 100 television sets per 100 householdes, 300 motor cars per 1000 inhabitante, etc.
As a rule technological limits have a higher degree of certainty and invariance than those in economic fields.

The example of the growing saturation of the households with TV - sets is illustrated by the following sketch 8. The ideal case assumes a s-shaped symmetric function, in practice the period between 0 and a saturation of 50 per cent will be much shorter than the remaining time period. If the course of the function is given up to 50 per cent saturation, than it is possible to calculate the degrees related to the following years using the formula

$$Y = \frac{1}{1 + \left(\frac{To}{t}\right)^{a}} ;$$

with
a = constant factor
y = degree of saturation (approaches 100 or the factor 1)
To = time in years from the start of the curve up to a saturation degree of 50 per cent
t = time in years from the beginning of the curve.

To give a numerical example:

	to	a	To
GDR	1954	2.9	10.5
West Germany	1952	2.8	11.5
Great Britain	1946	3.0	11.0
USA	1946	2.8	6.2

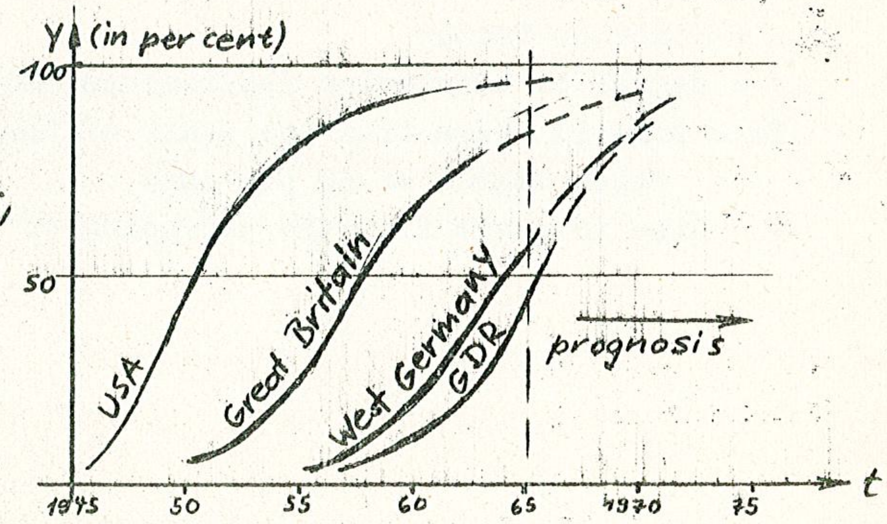
The table shows, that e.g. the G.D.R. the supply with television sets started in the year 1954, after 10.5 year, i.e. 1965 about 50 of the households were equiped with TV -sets. Using the above mentioned formula we are in a position to predict i.e. the degree of saturation in the year 1974 in the DGR:

$$y = \frac{1}{1+\left(\frac{To}{t}\right)^{a}} = \frac{1}{1+\left(\frac{10.5}{20}\right)^{2.9}} \approx \underline{0.87 \text{ or } 87 \text{ percent}}$$

Naturally such calculations have to consider innovations in related fields, in our case the introduction of television in colour.

Sketch 8:

Saturation prognosis, television sets per 100 households.



f) Substitution analysis

Under a total substitution we understand the introduction of completely new materials, products, procedures of production, etc. , substituting the traditional solutions, such as

- new kinds of satisfaction of the population needs (e.g. colour TV),
- qualitatively new raw materials (e.g. substitution of metals by plastics)
- new kinds of technology (e.g. shifting from cutting to pressing techniques),
- alternations of the technological and physical principles to solve problems (e.g. neon tubes instead of bulbs),
- substitutions of raw materials (e.g. coal - crude oil), which are connected with far reaching structural changes.

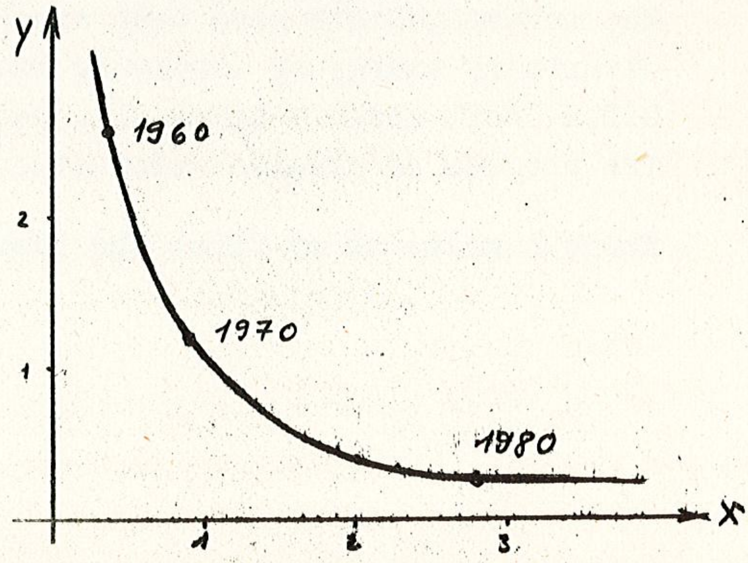
Extent and tempo of substitutions depend on the price relations and the relation of the quality or the use value of the two competing products. The substitution prognosis can be represented by a hyperbolic function like sketch 9:

Sketch 9:

Substitution prognosis,

with $y = \frac{\text{production of A}}{\text{production of B}}$

and, e.g.: $x = \frac{\text{prime cost of A}}{\text{prime cost of B}}$



To take an example : on principle it is possible that that function can illustrate the substitution of electro energy produced in traditional thermal power stations by electricity based upon nuclear power. Nuclear power will outrun thermal power corresponding to the development of the price relation of the two kinds of energy. Prognosis carried out in the USA obtained the result, that the costs of both energies per unit will become equalized about 1970, and about 1980 nuclear power stations will be able to produce energy with only half the expenditures per unit required by traditional procedures. It is obvious , that such projected cost or price relations can be used as a starting point to come to conclusions about the progress of the substitution. Of course a lot of other factors must be considered.

In connection with research work dealing with the subtitution of coal by crude oil we gathered experiences concerning substitutional effects.
In this case our calculations combined physical and value units. The investigations have been aimed to optimize the utilization of primary energy by comparing the effectivity of coal (in the G.D.R. soft coal) , crude oil, natural gas, and refined gas in the process of chemical production.

Table 2 gives us at first the thermic effectivity data :

Table (2)

Thermic Effectivity of Different Primary Energy

To produce :	Thermic effectivity of			
	coal	crude oil	natural gas	refined gas
1. fuel	0.480	0.874	-	-
2. methanol	0.222	-	0.547	0.605
3. ammonia	0.197	0.428	0.550	0.607
4. acetylene	0.248	0.564	0.300	0.600
5. sewer gas	0.565	0.720	0.582	0.712
6. electro energy	0.305	0.357	-	-
7. steam	0.754	0.795	-	-

It is obvious, that crude oil has a higher thermic effictivity, a better rate of utilization , than soft coal in all cases, but to a different degree. It goes without saying that the table gives us first references regarding the sequence of the substitution of coal by crude oil. But we have to consider, that the thermic effectivity not represents the economic efficiency as a necessity, caused by different prices , transportation costs , etc. Thus the variants of substitution must be investigated using not only physical but also price terms, as shown in the following comparison examples , which also includes comparison of labour productivity (table 3):

Table 3

Comparison of the Economic Efficiency of Coal and Crude oil

	Investment costs Mark/ton	prime cost Mark/ton	energy Kwh/ton	productivity ton/ worker
Fuel				
coal	1550	630	990	100
crude oil	140	250	100	1800
Diesel oil				
coal	1480	360	910	100
crude oil	40	200	20	1800
Acetylene				
coal	1500	2400	12400	200
crude oil	900 - 1500	500-700	840	650
etc.				

Such calculations and comparisons are solid foundations to start prognostic selections of most effective production processes. A next step can be the calculation of the cut down of prime cost. The results are registered in table 4.

Table 4[1)]

Lowering of Prime Cast per Year Processing
Crude oil instead of Coal

Product	million Mark	percent
1. acetylene	178	62.9
2. acetaldehyd	30	58.8
3. butadien	90	61.6
4. acrylnitrit	40	57.1
5. ammonia	50.5	51.8
	388.5	60.0

Our short survey upon prognostic methods doesn't exhaust the series of possible procedures. All the mentioned methods will be used in a combined form to set up models and to simulate future situ ations. The top level prognostication at last will use the theory of games to come to strategical analysis, but their applicability depends on many factors, out of which we would like to repeat the outstanding importance of the improvement of the information systems.

1) Table 1, 2, and 3 ct. " Socialist Management of Industry", Part II, edited by the Economic University Barlin as a textbook for extra-mural students, pp. 155-156.