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Notes on the Application of Cybernetic Concepts in Economy

Present trends confirm the increasingly larger utilization of cybernetic means of analysis and prediction, of an enormous amount of knowledge, concepts, methods and techniques, made available by modern science for men, in view of consciously controlling the material production process, i.e. economy.

During the early forties, while all over the world cybernetics was assuming the status of an independent discipline, a great number of scientists began to visualize the possibility of its practical application in various other fields, besides those of servo-systems and automatic control theory, for which it was first devised.

Although the period elapsed since then is comparatively short, the impetuous pace of its progress, the permanent extension of its object, the improvement of technique and research methods definitely place cybernetics in the focus of the contemporary scientific creation process.

Through its numerous applications in a wide range of scientific and practical fields, cybernetics has become of daily usage for the scientist, the research worker, the engineer, the economist and for experts in some other areas.

Indeed, economy ranks among the fields for which the introduction of cybernetic methods has outstanding implications.

Scientists, teaching staff, experts all over the world are unanimous in considering that among the sciences concerned with the knowledge, analysis, organization and control of economic processes, a prominent place is held by economic cybernetics. The widespread diffusion of cybernetic principles in economic areas has been objectively determined by the need of securing a possibly optimal direction of economic phenomena, by the requirement of

adjusting management and organizational methods to contemporary scientific achievements.

By applying cybernetic principles to the management of any kind of activity, and above all economic activities, this science has become an outstanding organization means.

Present trends confirm the increasingly larger utilization of cybernetic means of analysis and prediction, of an enormous amount of knowledge, concepts, methods and techniques, made available by modern science for men, in view of consciously controlling the material production process, i.e. economy.

It is long ago since prominent economists, such as the French physiocrat François Quesnay, the founders of English classical economy William Petty, Adam Smith and David Ricardo, and particularly Karl Marx, in the basic concepts of his economic theory, viewed economy as a unitary entity, constituted from mutually conditioned spheres of activity.

While it is not our purpose to describe in detail the implications resulting from the application of cybernetic principles to social life, we consider, however, that in economy, the whole set of existing activities, direct connections and feedback, leads to the idea that any economic organization, either an enterprise, a branch, a sector or the whole economy, may be viewed as a cybernetic complex.

Cybernetic complexes in economy cannot be conceived apart from the entire set of relations with their economic, social and political environment. Each separate system comprises a number of complex economic activities materialized in the production or servicing processes, as well as a number of planning, supplying and sales, financial, credit and many other activities.

It is mandatory for the cybernetic model of an economic system to synthesize both the parameters characterizing its economic function and those designed for direction, control functions and connections with the other economic bodies.

Under these circumstances, economy as a whole constitutes a huge cybernetic system, made up in its turn of other cybernetic systems, that is the economic branches, or of sub-systems represented by sub-branches of economy, joined together according to a set of connections responding to the objective trends towards the system's progress, and usually securing this progress in the dynamic sense of development.

Keeping in mind that beside this set of connections, each economic system has a dynamic variation with time, that economy is an evolutionary cybernetic system, whose parameters are continuously changing according to the increase or decrease of some activities or resources, we may assess that the general cybernetic system of economy is the most complete social cybernetic system.

An essential feature, qualitatively distinguishing economic cybernetic systems from other systems, is the fact that the management and control function is characterized by the presence and conscious activity of man.

The social body interested in an as favourable development as possible of the economic processes taking place in the system is continuously following up their progress and, as a result of analyzing the data obtained, decides upon the measures to be taken in view of canalizing the system's behaviour

in a predicted direction. As coupling and economic progress or growth are intrinsic features of any economic cybernetic system, we are led to consider, in cybernetic terms, the operation of these systems as open bodies, continuously subjected to the influence of external factors, which are not controlled by the system's behaviour.

Consequently, the control mechanism of any economic cybernetic system must permanently secure the optimal progress of the respective system specific activity, as well as the removal of interfering disturbances resulting from its connection with other systems.

This is why in economy, the program concept, viewed as a basic element governing cybernetic systems, must be considered in very broad terms. Each program, specific of a cybernetic system, may be considered as a model simulating its development only to the extent it mirrors the real system requirements. We must keep in mind that the set of interdependency connections contained in each economic system leads to a high degree of complexity of the directing and control system.

The complexity degree of management and control activities increases as we are progressing along the scale of economic cybernetic systems up to the national economy level.

By operating with programs on a national economy level and by making available conditions which allow the accomplishment of a unitary management and directing mechanism of social life, socialism offers extremely favourable conditions for the achievement of an optimal control of the entire economic cybernetic system. Planned economy effectively accomplishes the feedback, since it is able to secure a practically unhindered effect on the functioning of the whole economic system.

The major tool used by the Government in socialism, in order to interfere as a regulator of social life, is the State plan. Actually, the plan is the predictive model of the general economic system. Economy dynamics bestows a dynamic character on the plan as well. This is why the plan may be viewed as a trajectory in the economic space, defining the major directions of economic progress and subject to corrective actions, according to social development requirements.

These amendments are accomplished either through influencing the rate of development of various constituent elements belonging to the system, which leads to general deviation removal, or through effecting some changes in the original program.

As a result of some branches or sub-branches growing more rapidly, or of some change in initially established quotas of economic development, the general deviations from the original program can be considerably reduced or even completely removed. Program rectification is involved whenever data illustrating the system's progress prove that solutions initially adopted can be further improved, or when new conditions prescribe the revision of some older ones. This conclusion derived from the application of cybernetic concepts in economy is fully verified by the whole economic practice.

In our country, the five-year plan for the time interval 1966 to 1970, laid out by year and economic unit, comprises the major directions of national economy progress defined in terms of elements already known at the time of its elaboration, the identification of some new material

resources, the organizational improvement of political and economic activities and of the entire social system, as well as the new demands of socialist construction development, requiring the under way amendment of some parameters characterizing the economic trajectory initially established and expressed by the five-year plan.

In this connection, we can mention the measures under way in order to ensure a more rapid growth of some sub-branches, such as electronics, electrotechnical industry, fine mechanics, the irrigation program, the improvement of provisions included in the five-year plan brought about on the occasion of perfecting annual plans, as well as other amendments made to the original program in accordance with new circumstances appearing in economy and in social life.

In orienting the progress of various branches in order to establish the directions and quotas of national economy growth as a whole, in securing a judicious coupling of various sectors of the economic cybernetic system, a particular significance is bestowed on balancing the mutual relationships between economic branches, an essential method in getting as accurate an idea as possible about the interrelations of national economic branches, a scientific tool in modern economy management.

As an illustration of the concern for the increasingly scientific substantiation of current and long term economic development programs, we can mention the measures taken in view of improving economy management, of securing the direction and control of the whole national economic complex in close agreement with political and social objectives, for the completion of socialist construction in our country.

In agreement with these measures of controlling the economic process, an important part is played by the organization of the economic information system. In performing the management and control function, in terms of securing an optimal trajectory for the basic parameters of the economic system, the assumption is made that it would be possible to know and to guide in the predicted direction the progress of the various parts making up the system, of the sub-systems constituting it. The insufficient knowledge of the effects exerted by some phenomena or the slow rate of response may lead to disturbances, corrected through wasting or withholding considerable material resources. This is why, in order to ensure the optimal operation of the economic system, a continuous flow of information concerning its state and its trends at various moments is required. The information volume necessary for an optimal operation cannot, however, be increased infinitely, since at a certain stage it is actually limited by material and technical grounds, by staff availability, by the cost of data collecting, processing and transmitting procedures. Information conveyance assumes a certain economic effort, translated in unavoidable expenditures, their magnitude depending upon the total development level of the economic system.

The process of continuously refining the economic information system, its adjustment to the requirements of economy management, derives from the general steps taken towards the improvement of activities in all national economy sections, in order to improve the organization of economic activity, to raise its profitability and effectiveness.

Owing to its ability to show the dynamic picture of economy as a whole and of its constituent forces, owing to the place it holds in the directing mechanism of economic life and in securing the cycle information — analysis — decision making, the economic information system could be compared to an actual nervous system of the national economy. In order to effectively fulfil its functions, the information system's structure and capacity must correspond to the real nature of economic processes, to the accuracy level set for the knowledge and direction of phenomena.

The necessity of permanently following up and directing the process of State plan implementation and budget fulfillment, of continuously investigating the efficiency of the planning system, of the financial and banking system and of goods circulation, of the wage and salary system, a.s.f., with a view of uninterruptedly adjusting them to the socio-economic reality requirements, constitutes the basic prerequisite, determining the scope and architecture of the information system, the volume and kind of data to be collected and processed for decision making.

The information system plays a prominent part in decision making on all levels of economy, starting with the enterprise and up to the economic branch or to the national economy as a whole. Viewed on this background, the information system structure must ensure a rational balancing between the degree of centralization and decentralization in data processing and transmission, as well as in economic decision making developed on this basis.

To be sure, the information system holds a central place in national economy management as a whole; however, through its constituent elements it must secure the necessary decision making ability at the level of the various sections making up economy, such as enterprises, future industrial central organizations, local authorities, Government departments and central economic institutions.

The wide application of cybernetic and mathematical methods and of modern computation techniques in economy requires, as was repeatedly pointed out, a proportionate endowment with computers.

The Romanian state makes continuous efforts in order to provide economy with modern computation equipment. A program has been developed, aiming at endowing national industry with mechanical and electronic computers.

We must, however, remember that this effort is a long term process, as determined by our economic capacities referring both to import and internal production. The fact that our material possibilities do not allow us to solve at once the endowment with the entire stock of modern equipment does not mean that we are postponing the application of cybernetic and mathematic methods in economy, nor the training of a number as high as possible of people able to utilize and to apply the modern economic computation techniques in solving economic problems.

In the directives concerning the 1971 to 1975 five-year plan elaboration, as well as the featuring of the essential lines of national economy development up to 1980, "the accomplishment of a dynamic and modern economy, directed towards the widespread application of electronics, automatics and cybernetics, towards the utilization of the highest level of modern technique in all fields, in order to secure a high degree of social labour produc-

tivity and, on this basis, the growth of the people's living standard" is particularly emphasized.

This is why the directing lines in training future experts and in scientific research activities must tend towards solving the problems we are confronted with.

In relation to these problems, the President of the State Council, Nicolae Ceaușescu pointed out: "If we wish to have electronic machines, to put economy on cybernetic lines, to automatize and chemicalize, we cannot do without medium and high level trained staff; only in this way will we be able to reach the targets set forth." *

In training the necessary staff, an important part is played by our high schools, by the technical departments as well as by the computation centres operating in educational institutions.

Starting from present and future needs, and taking into account the fact that during the next years Romanian economy will be equipped with an ever increasing number of computers and other modern equipment, the higher and technical education systems have been adapted according to these requirements, simultaneously with the attraction of an ever increasing number of expert staff from economy in the activities of the computation centres.

As a result of our own practical knowledge as well as of the worldwide experience, the sound training of experts in economic systems and computerization analysis, in the field of computer programming and of data processing techniques, has been laid down at the basis of the education program.

It is increasingly obvious at present that the improvement of economic activity management and organization is closely related to the application of mathematical and cybernetic methods in economy, among which an important place is held by planometrics, econometrics, operation research, economic cybernetics, mathematical programming and simulation techniques, the investigation of dynamic systems, and so forth.

The training of future experts, as well as scientific research itself on the application of cybernetic methods in economy, must be directed towards subject matters of major significance, having wide implications in the economic life of our country, simultaneously with the development of theoretical activities and the broadening of concerns for practical developments of results obtained.

In the framework of scientific research an increased concern is required for mathematical modelling techniques designed for concrete economic phenomena, with a view to be able to predict their progress and hence to use scientifically substantiated planning methods.

The great number of problems raised at the various levels of economy, their significance being illustrated by mentioning for instance only the technical and material supply question, make necessary the development of intensive research in the field of the queueing theory, starting with the concrete facets of our economic reality.

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* From the report on the development of general, vocational, technical and higher education in the Socialist Republic of Romania, at the plenary meeting of the Central Committee of the Romanian Comunist Party, held from 22 to 25 April, 1968.

The large-scale scientific organization of production and labour can be effectively backed up by a more stringent concern in the field of operation research for the orientation towards the many aspects of programming and efficient management of manufacturing in industrial enterprises, towards transport problems, etc.

From this point of view there is a particular need to extend and generalize the application of several variants of the critical path method in the programming and follow-up of the different activities in industrial units, building sites, design and research units ; this method regulates the management control activities.

By making the efforts of the widest possible number of scientists and research workers converge round these preoccupations, we must continuously develop the whole of our scientific effort in the service of growth of the economic and social potential of our country.

NOTES SUR L'APPLICATION DES PRINCIPES DE LA CYBERNETIQUE DANS L'ECONOMIE

L'application des principes de la cybernétique à la direction de toutes les activités et en particulier de l'activité économique fait de cette science un puissant instrument de direction et d'organisation.

L'ensemble des activités et des connexions directes et inverses existantes conduit à l'idée que tout organisme économique — qu'il s'agisse d'une entreprise, d'une branche, d'un secteur ou de l'économie toute entière — peut être considéré comme un complexe cybernétique.

L'économie est donc, dans son ensemble, un immense système cybernétique, composé à son tour d'autres systèmes cybernétiques , à savoir les branches économiques, ou des sous-systèmes qui sont les sous-branches de l'économie couplées entre elles, sur la base d'un ensemble de connexions répondant aux tendances objectives de l'évolution du système, en assurant cette évolution dans le sens dynamique du développement.

Voilà pourquoi, dans l'économie, la notion de programme, en tant qu'élément fondamental de la direction des systèmes cybernétiques, acquiert une acception extrêmement large. Chaque programme caractéristique pour un système cybernétique peut être consideré le modèle de son développement seulement en la mesure où il reflète les exigences du système réel.

L'organisation du système informationnel de l'économie a un rôle important dans la direction des processus économiques. L'exercice des fonctions de commande et de réglage, dans le sens d'assurer une trajectoire optimum aux paramètres fondamentaux du système économique, suppose la possibilité de connaître et d'orienter dans la direction prévue l'évolution des différentes parties du système et des sous-systèmes qui en font partie.

Sa capacité de présenter un tableau dynamique de l'économie dans son ensemble et des forces qui la composent, la place qu'il occupe dans le mécanisme directeur de la vie économique et dans la continuité du cycle information — analyse — décision, nous permettent de comparer le système informationnel de l'économie au système nerveux d'un être vivant.

НЕСКОЛЬКО ЗАМЕЧАНИЙ О ПРИМЕНЕНИИ КИБЕРНЕТИКИ В ЭКОНОМИКЕ

Применение принципов кибернетики в руководстве любым видом деятельности и, в первую очередь, экономической деятельностью, преобразовало эту науку в мощный инструмент руководства и организации.

Ансамбль деятельности и существующих прямых и обратных связей ведет к выводу, что любой экономический организм, относится ли это к предприятию или речь идет об

отрасли, об отдельном секторе, или обо всей экономике, может рассматриваться как кибернетический комплекс.

В этих условиях экономика во всем её ансамбле представляет большую кибернетическую систему, которая в свою очередь составляется из других кибернетических систем, т.е. из экономических отраслей или из подсистем, представляемых взаимосвязанными подотраслями экономики, на основе ансамбля связей, отвечающих объективным тенденциям эволюции системы, обеспечивая эту эволюцию в динамическом смысле её развития.

Поэтому, в экономике понятие программы, как основного элемента управления кибернетическими системами, должно рассматриваться в очень широком смысле. Каждая программа, специфическая какой-либо кибернетической системе, может считаться моделью развития этой системы только в такой степени, в которой она отражает требования реальной системы. Для управления экономическими процессами важную роль играет организация информационной системы экономики. Выполнение функции управления и регулирования в смысле обеспечения оптимальной траектории основных параметров экономической системы, предполагает наличие возможности знания и ориентации в предвиденном направлении эволюции различных частей системы, подсистем, входящих в её состав.

Благодаря своей способности показать динамическую картину экономики в ансамбле, её составляющих сил, благодаря месту, которое она занимает в механизме управления экономической жизнью и в обеспечении продолжения цикла «информация — анализ — решение», экономическая информационная система может быть сравнима с настоящей нервной системой народного хозяйства.