Dr. M.C. DEMETRESCU

Entropy, Information and Control in Economy

The automation and data processing techniques development makes possible to turn the intricate system analysis into efficient, operating ideas.

1. ECONOMIC EPISTEMOLOGY AND ENTROPY

Entropy is a measure for the disbalance of energy in a system. It is a natural law which causes isolated systems to change their internal structure if they are left alone. Entropy has been defined as the ratio between the amount of heat available for work (that can be transformed into mechanical work) and the absolute temperature of the system.

Like heat, free energy (the energy that can be transformed into work) always dissipates by itself and without any loss into latent energy. By the time all that heat or energy has been evened out the mentioned ratio has risen to the unit. The final outcome is a state where all energy is latent. The system is then dead and the activity within it stops: the heat death as it has been called. The universe, comprising not only energy but also material structures, continuously undergoes a qualitative degradation.

The degradation of the universe signifies that there is a constant tendency in nature for order to turn into disorder [1]. It is a law of nature that entropy tends to its maximum. Disorder can be measured by means of Boltzman's formula:

$$S = -u \sum_{i=1}^{m} p(x_i) \log p(x_i) \qquad \sum_{i=1}^{m} p(x_i) = 1,$$

where S is entropy, u is a physical constant, depending only on the used logarithms and on the determined unity for measuring the information, x_1, ..., $_i$, ..., x_m are the microstates, and (px_1), ..., $p(x_i)$, ..., $p(x_m)$ the probabilities of the microstates.

The assumption is that log stands for natural logarithms. The closer the m probabilities $p(x_i)$ are to $1/m$, and the larger m is, the less order exists in the system.

When the microstates have the same probability $1/m$ [2] Boltzmann's entropy is:

$$S = u \log m.$$

A close system tends to move from a less probable state to a more probable one and the rate of change is propotional to the logarithm of the disbalance of probability existing at a given time.

The higher the disorder, the greater is the probability of its occurring and, consequently, a close system, such as nature, has a tendency to pass from any state to one of higher disorder.

Therefore, in a system in which its microstates have a sationary probability, entropy remains constant. This entropy is the highest entropy actually possible in this system (without external interference).

A close system changes its microscopic states or the probability distribution of its microscopic states only when, through this change, its entropy can increase in any state.

Living structures can rule the laws of elementary matter [3].

The simple cell being a highly ordered structure, it is possible for such a structure to avoid being thrown into disorder because a living organism maintains its highly ordered structure by absorbing low entropy from the environment so as to compensate the entropic degradation to which it is continuously subject. As Schrödinger explained [4], life does not feed on mere matter and energy but on low entropy.

Life is characterized by the struggle against the entropic degradation of mere matter.

Professor Georgescu-Roegen is perfectly right when stating that the law of entropy is the most economic law of all the laws of physics [5]. From the purely physical point of view, the economic process is entropic: it neither creates nor consumes matter or energy but only transforms low entropy into high entropy. Unlike the physical process of material environment which also is entropic, the economic process masters, according, to certain rules, the entropic march from low entropy towards high entropy, whereas in nature there is an uninterrupted march towards disorder. The activity of dominating and directing the entropic march feeds on low entropy and, in this way, the effective economic process is more efficient than the automatical creation of natural disorder in producing higher entropy, respectively waste.

All the economic life feeds on low entropy, raw materials and matter, which all are highly ordered structures. Order reprezents objects which are useful to us, in contrast with disorder of particles and molecules of the same objects when diffused so as to be of no use to us. Low entropy is a necessary condition for a thing to be useful.

The primary objective of economic activity is undoubtedly the satisfaction of certain basic needs, some biological needs absolutely essential for survival.

Biological life is characterized by low entropy. The level of these needs presents structures with a clear organization, because this is a simple organization in which necessities are few and are satisfied by little processed objects, forming structures of high organization. As soon as these original needs are satisfied, new needs appear in great variety. So structures lose their cla-

rity and transparence. The least urgent needs, i.e. the most distant from their physiological origin become important. Entropy increases and the organization system diminishes. Since structural evidence wants clarity, investigations have to be undertaken in order to know the needs, preferences and tastes.

The scarcity of goods is also explained: 1) by the fact that the amount of low entropy within our environment decreases continuously; 2) because a given amount of low entropy can be used by us only once. Otherwise, every economic accumulation would be everlasting. The burning of a piece of coal does mean a speedier diffusion of its free energy than if the same coal were left to its own fate.

The economic process consists of a continuous transformation of low entropy into high entropy, that is into irrevocable waste, accelerating the entropy of the environment. In transforming low entropy into economic ends man uses instruments, capital, equipment, plants, which enables him to obtain the same amount of low entropy with less expenditure of his own free energy than if he used only his organs.

Processing low entropy for economic targets is a progress also comparatively with the entropic efficiency of animal or vegetal kingdom.

II. INFORMATION: RECONSTRUCTION OF OUR ORGANIZATIONAL IDEAS

The organization degree of a system moves against the direction of entropy. While gaining in entropy, the system loses in organization. For this reason it is more explicit to measure the growth of organization by the negative entropy called negentropy, $N = -S$. Gaining in entropy, a system loses negentropy or its equivalent, information.

When, rising to the unit, entropy has attained its maximum value, there is nothing to say about the system which is dead and respectively has no more information to yield.

The variation of information is opposite to the variation of entropy. Information moves in the same direction with the uncertainty. Coined from the Latin word *informare*, information signifies to form, to learn, to put into a form, to give a form, to represent, to put in order, to order or arrange some elements or parts into a system, to classify them.

Information is a very broad notion. Norbert Wiener said that information is "a name for the content of what's exchanged with the outer world as we adjust to it, and make our adjustement felt upon it. The process of receiving and of using information is the process of our adjusting to the outer environment and of our living effectively under that environment. The needs and complexities of modern life make greater demands on this process of information than ever before... To live effectively is to live with adequate information" [6].

Most of us have some intuitive feeling for what is meant by the amount of information. We can register this feeling by the amount of surprise we experience when being told that a particular event has occurred. When the probability of an event is 0.99 there is little uncertainty and the information to be expected is small. When the probability is 0.50 the uncertainty is very great and the information to be expected very large. The more unlikely

the event before the message on its realization, the larger the information of this message. Information moves against the direction of probability. Information is a decreasing function of the probability of an event and it is defined in te ms of logarithms of the reciprocal of probability. It is the reverse of entropy which is an increasing function of probability, being defined in terms of logarithms of probability. As entropy always tends to increase, information tends to continually decrease.

A growth of the number of a system's possible states means a decrease of information and an increase of entropy.

Let $S = u \log P$ be the entropy of a system in time t_0; P is the number of microstates of the system, the constant u being a matter of appropiate choice of the logarithmic base.

If the system moves in time t_1 from the microstates number P to $P'(P' > P)$, then the system has an entropic variation equal to $\Delta S = u \log P' - u \log P = u \log \frac{P'}{P}$.

S represents the amount of information about the decrease of uncertainty (increase of probability), with the change from the primitive entropic state to a new entropic state, the entropy of the system increases, the new state being more probable in accordance with the mentioned law of systems. A state is more probable when it agrees to a greater diversity or variability of possible states.

Suppose we wish to move the system inversely from the disorganized state P' to the more organized state P. In this sense we need certain information. This information can be measured by the difference between the total information corresponding to the a posteriori state P' (more disorganized) and the total information corresponding to the a priori state P (more organized). The formula of this information is $I = u \log \frac{P'}{P}$.

The amount of information necessary for gaining in order is proportional to the logarithm of the disorganization decrease.

From this equation $I = u \log_e \frac{P'}{P}$ it is easy to see that $\frac{I}{u} = \log_e \frac{P'}{P}$ and $\frac{P'}{P} = e^{I/u}$. Therefore $P = \frac{P'}{e^{I/u}}$.

P is inversely proportional to information, that is the growth of information means the decresing of the state of disorganization as P is less disorganized than P'.

It is necessary to have certain information for coming back to more ordered states. This information measures the necessary elements for the reconstruction of the system's initial state, starting from its final state. It is obvious that the presence of some order or regularity, of some steadiness or evenness simplifies the task of the observer, exempting him from a certain amount of information. On the contrary, if this order is destroyed, to reconstruct it we need to obtain more information, namely the amount of information involved in that order and requested by it. Depending on the source of disordering, P varies in mathematical expression but always $P < 1$.

P is a qualification of the degree of disorganization depending on the amount of information. Then $W = 1 - P$ is a qualification of the degree of organization and

$$S_p = S_{p0} \times W$$

where S_p is the system performance and S_{p0} the system optimum performance.

If the disorganized degree $P = \frac{P'}{e^{I/u}}$ represents, say 0.3, then the degree of organization is $W = 1 - P = 1 - 0.3$, then the degree of organization is $W = 1 - P = 1 - 0.3$ and only 0.7 is attended from S_{p0}, the level of the system optimum performance.

With the decrease of disorganization, the distance from the ideal perfect organization level also decreases. It is important to see that the degree of organization increases with the growth of information.

The organization structure in an enterprise may regard for instance plant programming, production-scheduling-programming-planning, machine loading, stock control, production control, dispatch sequencing, order processing, cost accounting, budgetary control. The ideal organization of an enterprise is the self-organization, an ultrastable machine, an organic whole. It is also a structure of systems of such a kind that its set of goals can be achieved.

System performance can be defined in terms of the resources available, specified goals, allowable risks, environmental factors. There are many measures for the system performance in addition to the most common one of gain and loss. Fixed budgets, turnover ratios, output per unit of time, sales performance (as for example, volume of sales per square foot), return in investment may be adequate measures to insure the desired system performance. In fact, more efforts are necessary for the development of performance measurement techniques, starting perhaps from certain categories, as time, cost and precision displayed by human activities in enterprises.

In designing an information system more inclusive values than the money efficiency of the system itself must be included.

The fact is that the organization is not yet optimally working nor is it perfectly operating. The information coming into the enterprise in the ways of orders, counter-orders, modifications to orders, claims, letters, telephone calls, etc., is not immediately fed into the production system organization and estimated. Bad documentation, false data or lack of data also occur sometimes.

The information channels in an organization and the points at which decisions are made, directly affect system performance. The flow of information can introduce time lags into a system.

There is a close interrelationship between organization structure, effective administrative systems and optimum management information flow.

The increase of ordering is intrinsically related to the growth of information. The development of information is conditioned by the security of getting the right information in an accurate form that is now possible on large scale through the advent of the electronic computers providing a great extent volume storage and error-free information. This signifies high costs for information but also a decrease in the overall labour force costs engaged in the manual system of information. The growth of information through the avail-

ability of computers allows substantial reductions in inventories, manufacturing cycle time, operator and machine lost time, indirect labour expenses.

The system effectiveness is a speed function of response to the rate of the information flow. There are different alternative responses to the rates of information flow which are optimal, given the type of decision of the organization structure or the cost. The speed of information flow is not the unique factor. The system performance depends also on some characteristics of information which must be right, accurate, expressed in a clear and usable form, apt to be summarized or aggregated.

The basic problem of the system performance is to determine what information is necessary, in what form and with what speed.

The research on system is going to have an impact on modern enterprise. The changes would apply not simply to the data processing groups, but to all parts of organizations to recognize the role of distribution, planning, management research, material control and other functions.

As professor Gabriele Morello pointed out, the system analysis approach concerns the marketing activities too, the enterprise being studied as a whole: "Its activities are considered as interrelated parts rather than as isolated components. Economic, social, legal, political, etc. dimensions come into the picture when the enterprise is considered as a set of objects related to each other and to their attributes. A variable degree of accurancy may be used in designing systematic models, going from a verbal or graphic description of their essential structure to a quantified and detailed analytical treatment of all their components [8].

According to the new system approach at the level of the enterprise, the basic ingredients of the organization — its people, techniques and material, though they may vary independently — can be optimally related to each other.

The new form of system analysis emphasizes the relationships between man and other variables and the influence of the enterprise's environment on them, offering the manager a means for bringing information proceeding from the engineer and the social scientist on the same background.

The development of automation and of data-processing techniques enables the transformation of the complicated system analysis into effective and operative ideas, allowing the manager to see that information is his basic material in determining goals and manipulating resources to achieve them.

The management task is to compel the system to determine interacting sub-systems (sub-fields of specialization) of the enterprise to uncouple and to engage them for a continuous adaptation to the environment. The function of optimum organization is to determine the inputs to the system and their characteristics and then undertake some engineering on the system so that control can be exercised and the appropiate ends attained [9].

There are three kinds of human activity products: substance, energy and information associated with control processes. It is only information for control that can counteract the growth of disorder. Control is in fact work against disorder; it is an activity aiming at order.

III. THE REVOLUTION IN CONTROL. A TRUE SCIENTIFIC TECHNICAL REVOLUTION

The most important function of information is control. Information for control is the most valuable facet of information. We meet information for control anywhere, in any place where man acts, where he commits reality and himself to behave according to certain desired performance criteria. Ruling nature's energy, discovering fire, making water wheels or steam engines, using thermo nuclear power, all of our past and present technologies are control activities. Man's physical and intellectual techniques of existence, the intercommunication processes of thought, word and deed are also controlling activities. Even the ethical behaviour of man is inner command controlling his acts.

As again Norbert Wiener said, "where mans's word goes, and where his power of perception goes, to that point his control and, in a sense, his physical existence is extended" [10].

Control has many and different meanings and until quite recently the negative approach was dominant. The greatest emphasis has been placed on the personal control of subordinate by superior in the pyramid of authority rather the non-personal control of an organization structure and the flow of information and ideas.

In a more restricted sense, control signifies means of coercion and checking up the differences between planned objectives or standards of comparison and actual results and performance, all this being put into practice in order to understand the reasons for variance. Control involves also direct or delegate responsibility of taking measures to obviate these differences or other excesses.

In the most extensive sense control has the very same meaning as management.

Control is primarily measurement and appraisal of performance through recording and interpreting actual results in the sense that one measures the deviation of actual performance from planned performance. Control proper starts from planning, which is the previous condition to measure the achievements. Stress is laid on more and more planning, since the better the planning, the easier the control.

As stated above, the control function resides not only in the area of control proper. It lies also in planning, as shown before, in operations and in research.

The process of control means, to a considerable extent, data processing and use.

It is possible to interpret the decrease of disorganization as a measure for comparing the structure of a group planned items and the structure of the fulfilled items (standards designating planned amounts of quantity, of cost or of time, production control, the setting of tolerances or of control limits, machine capabilities, norms, etc.) or as a measure of achivement of a group of planned tergets.

For a structure A', consider P'_1, P'_2, ..., P'_m, the a posteriori states of materialization of some a priori planned objectives of a structure A, P_1, P_2 ,.. ..., P_m.

The absence of information is shown by $P = P'$, signifying the plan fulfilment in an identical structural form. With the growth of information, in other words, with the growth in the differences between P_i and their corresponding P'_i. the performance of structure A' varies from planned objectives or standards of a structure A.

It follows that

$$I = \sum_{i=1}^{m} P'_i \log \frac{P'_i}{P_i}$$

$$\Sigma P'_i = 1; \quad \Sigma P_i = 1$$

where I stands for the amount of information measuring the non-fulfilment of the structure of planned objectives, the failure to obtain the structure of the plan. On the basis of this expression we obtain a measure for the deviations of the structural achievement as a whole, a measure of the structural performance of the plan targets.

The following case will illustrate the calculation. We shall refer to the retail sales through socialist trade in a Romanian district in 1966, 1967 and 1968.

Retail sales through socialist trade:

	1966		1967		1968	
	Planned	Fulfilled	Planned	Fulfilled	Planned	Fulfilled
Total	100.0	100.0	100.0	100.0	100.0	100.0
Food-stuffs	34.0	35.0	30.0	36.0	33.0	34.5
Public catering	13.0	14.0	13.0	13.0	13.0	12.0
Non-food goods	53.0	52.7	56.0	52.0	54.0	53.5

Expressed in proportions, we have for 1966

$$I = \Sigma P'_i \log \frac{P'_i}{P} = 0.353 \log \frac{0.353}{0.340} + 0.1201 \log \frac{0.120}{0.130} +$$

$$+ 0.527 \log \frac{0.527}{0.530} = 0.001 \text{ bits}$$

In the same way for 1967 $I = 0.008$ and for 1968 $I = 0.002$

The non-fulfilment of planned proportions was aggravated in 1967 but it seems that some improvement in planning the proportions reduced the variance between planned and achieved objectives in 1968.

I furnishes information about the extent of the disorganization level of the achieved structure as a result of the failure to carry out the proportions between the plan targets of a planned structure. The non-fulfilment of planned proportions presents a great importance in economy as the plan is not a collection of separated and isolated targets but an integrated whole in which proportions are planned too. The non-fulfilment of planned proportions may lead to disblance or distortions, with multiplicative effects on other sectors, hampering the balanced development of the economy. Certainly, in this way we do not know whether performance was inadequate or the goals were incorrectly set, being necessary to determine the reasons for variance and see

how performance can be improved in those cases where it has fallen short of the objective.

In the past, control was interpreted exclusively in terms of financial aspects of performance. After the accounting, followed the time sizing of output (work measurement), the quantitative aspects of production performance control (production rate and volume, inventory turnover, equipment capacity and utilization) and the control of production quality.

Control provides through these four ways an important amount of information, more accurate and precise than any other activity of the enterprise.

But managers need more relevant information. For instance it is necessary to have non-material aspects of performance such as measuring the behaviour of an individual in the enterprise, his contribution to the group of which he is a member, etc.

Comparisons to other performance values or comparisons to other plants of the same enterprise, to other enterprises in the same industry, to different industries and to the regional or even the national economy as a whole are always useful.

It is possible to measure any aspect of performance by designing landmarks, specifically for each situation.

All control procedures should be planned out as attentively as the targets on which they are to report.

The real need in applying computers is not only to manipulate the existing knowledge but also to identify the factors that affect business situation of the enterprise and the influence of these factors exerted in any given circumstance.

This is the control information regarding analysis with the purpose of extracting conclusions which are important for the future and generally for decision making.

The product of the manager is the decision, either for planning or for control, either strategic or routine. As such, management [11] is synonymous with decision making.

Mathematical or logical decision rules are also controls since they enable specific system performance and contribute to the achievement of different parts of control.

Any study of the decision making process must cover the areas of ends, the necessary information, the control and the character of management. It seems that the most important factor is the level of information. Information is the key ingredient for a better management control.

In a management control system the idea of control can be expressed in terms of information in view of enhancing the total communication flow and interchange within a business organization. All business organizations are, in a sense, communication systems.

Managerial control requires the existence of a true network of managerial intelligence. An effective management control system requires an information system which distributes to each individual the information indispensable to continue to the end the work that must be done by him.

An organization design itself is a management control dimension and therefore a system is under control when it is organized, when moving towards

desirable ends. The degree of control is intricately linked to the amount of effective information available to the system.

The system being in an evolutionary and purposeful process of self-organizing, the control exerted in this process is proportional to the amount of information exhibited by the system about itself. The system appears to be under control in proportion to its self-organization. Growth, then, is a self-organizing activity of a system in which the system learns to be what it is [12].

All these forms of performance control are essentially designed to measure departmental efficiency rather than any impact on the other departments and on the whole enterprise to achieve overall objectives.

In the design of management control systems, measurement of system performance should be an integral part of management control although established bases for measurement in accordance with accepted standards do not accurately express performance nor provide control.

For instance, a higher rate of stock-turn may result in a stock shortage. For this reason turnover may be an insufficient measure to make certain the desired system performance.

System design precedes design of management control and therefore system requirements must be connected to the control methodology.

Control information can then be produced in the process of current transactions based on integrated systems of man, material, and funds used by management to indicate in precise detail the forecast and make certain the desired outcomes from such systems.

Control is difficult because life injects too much variety but, the more adaptable control systems become, the greater variability they will be able to cope with.

Through learning and general adaptation a system becomes not only organized but responsive too. In fact this is to be self-organizing a self-disciplined attitude of mind, a way of learning about itself and of keeping itself under control despite external change and internal stress of contrary tendencies locked within [13].

Studying decision making in areas of management as a learning process is a very promising road because learning is a series of decisions selecting, classifying, combining and integrating. By its very nature management belongs to the learning theory, being essentially a process of adjustment.

The best example of control is the automatic one, as for instance the household thermostat is. If the temperature in the room falls, the heater will be automatically turned on, or turned off if the temperature rises. A kind of thermometer keeps the heater informed about the temperature in the room. Control therefore signifies adjustment in response to external conditions of arranging a system towards optimal performance of self-regulation.

The flow of information round a system as a means of self-control is studied by the new science named cybernetics or the science of control. It is an interdisciplinary science concerning new modes of organization, techniques of information handling and decision making, mathematical models of learning and other procedures helping an enterprise to be more adaptive and responsive to change.

The techniques of Operations Research facilitated by computers in addition to the modern data communication devices provide now the systems

function with new tools having great power in treating an organization and its administrative processes and in unfolding integrating management information systems for better managerial decision making and control.

The overall complex interrelationship of organizational structure parts requires the integration (by means of the system analysis) of business data flow throughout the organization and provision of accurate feedback of information to management.

It is a great improvement comparatively with the accounting system, the first system for developing management control information.

In designing management information systems we try to establish the most efficient methods of generating control information and the responsabilities attached to this process or to provide information to management in order to better plan, operate and control business.

The control sub-system is the management control function, being made up primarily of decision making and information flow. The variables which are to be manipulated are basically the organizational structure, the information flow network and the decision rules. The management control sub-system takes information from the other sub-systems, such as customer demands, stock status and costs, and by means of decision rules provides the operations sub-system with such information as a production schedule, transport orders and sale price.

Within the other sub-systems there are also parameters which can vary such as costs, general economic conditions, etc. It is important to test the sensitivity of management control system to variation in the parameters within the other sub-systems, or to compare with some other management control systems.

At the lower level the management control sub-system regards only those decisions which are necessary for the operations sub-system directly, such as the quantity of raw material to be purchased, the production level to be set, etc. At the higher level the management control sub-system makes decisions affecting its own operations. For instance, a decision rule at one node (a point at which information is received, processed and transmitted) determines a change in the decision rule at another node.

Each node will have a certain internal structure and several tasks to perform, be they simple data processing or decision making which will take time, and some queueing problems may appear. The node communicates with other nodes receiving and sending information, either in the form of reports or as specific request. Associated with every information channel, time delays, costs and random noise result. There would be a choice of sending a report by a slower and cheaper medium or a faster but more costly medium.

Any solution to management control systems problems in an enterprise must take into consideration that the inf ormation system does not work in a laboratory static environment but in the dynamics of the total administrative process in modern organizations. The enterprise operates in a market strongly influenced by agressive factors such as changing economic conditions and technological advances, which require, for enterprise's survival, programs of diversiform expansion.

A better management control needs a careful and deep examination of the esential factor which is the information in all its aspects in the economic environment.

To meet the information requirements of management control, the communications improvement between the various functions of an enterprise is the main problem, and not just the setting up of source data equipment to process larger volumes of inf ormation or the use of more powerful computers. The emphasis should be laid on the quality of information, not on the early maximum utilization of set up data processing hardware.

The decisions are always taken by the central and local command bodies of the organization chart which has the most information. Therefore, a structurally consistent modelled control system mu st beabundantly and continuously supplied with information which does circulate in an intrinsically self-regulating way with sufficient feedback and interconnection between the subsystems' central and local points of command.

The solution of the major systems problems in management, decision making and control is still an extremely difficult and compicated task. Considerably more knowledge is needed in order to design well operating large-scale complex systems. In the design of control systems little is known about how the system will behave under the changeable conditions, even neglecting the intrusion of the human factor into the engineering system.

Experimentation cannot be carried out in the actual economic world. System modification, repetition or control of experiments are impossible and there are not laboratories for testing new ideas and methods. There are no experimental means for discovering fundamental laws of complex control systems.

Control theory calls for investigation of the operation of feedback in the control processes. In feedback systems, actual achievement is compared with a desired result, and information about any discrepancy is signalled to a controller in order that this can use it in deciding what corrective action should be taken. The operation of feedback enables a system to deal with uncertain knowledge of the likely outcome of a particular action and to make predictable the output resulting from variations in input.

Computer simulation and operational gaming in addition to certain statistical techniques provide new rapid means of investigating complex problems such as control systems. The computer is able to inspect a year of simulated activity in some minutes. Data on system performance, unavailable at present, can be obtained too.

All the operations of an enterprise can be treated in simulation: financial control, cost accounting, scheduling, equipment maintenance and replacement, new product development, relations with the customers, relations with the personnel and all the problems involving decision-making situations.

But still much work remains to be done in applying simulation operational research techniques and other mathematical and statistical tools. The most difficult performance would reside in enginering design on control systems, applying the results of scientific inquiry to the specific reality, designing or planning for solutions of particular problems in the sense requested by the manager who in fact implements a system being responsible for the system's working and its results.

REFERENCES

1. BERGSON, H.: *L'évolution créatrice.* Félix Alcan, Paris, 1911, chap. III.
2. PETERS, JOHANNES: *Einführung in die allgemeine Informationstheorie,* Springer Verlag, Hamburg 1967, p. 30.
3. DE CHARDIN, TEILHARD: *La vision du passé.* Editions du Seuil, Paris, 1957, p. 209.
4. SCHRÖDINGER, ERWIN: *What Is Life?* Cambridge Englewords, 1944, p. 27
5. GEORGESCU-ROEGEN, N.: *Analytical Economics.* Harvard University Press, 1966, pp. 92—93.
6. WIENER, NORBERT: *The Human Use of Human Beings.* Houghton Mifflin, Boston, 1950, p. 124.
7. BONSACK, F.: *Information, thermodynamique, vie et pensée.* Gauthier Villars, Paris, 1961, p. 75.
8. MORELLO, GABRIELE: *Multi-Country Marketing Strategy.* Seminar on New Products and New Markets, International Marketing Federation in collaboration with Asociación Espanola de Marketing, Palma de Mallorca, 20—22 June, 1968.
9. PARSONS, TALCOTT, and SMELSER NEIL J.: *Economy and Society.* The Free Press, New York, 1965, p. 16—18. See also SOLO, ROBERT A.: *Economic Organization and Social Systems,* Bobby Merril Comp., New York, 1967.
10. WIENER, NORBERT: *The Human Use of Human Beings.* Houghton Mifflin, Boston, 1950, p. 104.
11. ALDERSON, WROE: *Marketing Behavior and Executive Action.* Homewood, Illinois, Richard D. Irwin, 1957, p. 86.
12. BEER, STAFFORD: *Decision and Control,* John Wiley, New York, 1966, chap. 14.
13. REVANS, R. W.: *Science and the Manager.* Macdonald, London, 1965, p. 124.

L'ENTROPIE, L'INFORMATION ET LE CONTRÔLE DANS L'ÉCONOMIE

La conception de l'entropie et les mesures qui résultent de la théorie de l'information sont adaptables à l'analyse des processus ayant lieu dans les structures de l'économie.

Par une telle méthode de calcul on peut réaliser la quantification des écarts des proportions dans une structure de la réalisation d'une planification quelconque par rapport aux proportions planifiées au début. Ainsi, on obtient une mesure du niveau de désorganisation résulté dans une structure, suite au non accomplissement des proportions comprises dans le plan. La non réalisation des proportions planifiées présente une grande importance dans l'économie, vu qu'un plan n'est pas une collection d'objectifs séparés et isolés, mais un tout intégré dont les proportions aussi sont planifiées.

L'information pour le contrôle de la réalisation d'une norme d'organisation ou d'une prévision de plan peut être ainsi mesurée et donner, par cela, la possibilité de conclure sur les décisions nécessaires à prendre.

ЭНТРОПИЯ, ИНФОРМАЦИЯ И КОНТРОЛЬ В НАРОДНОМ ХОЗЯЙСТВЕ

Понятие энтропии и измерения, выведенные из теории информации, применимы для анализа процессов, происходящих в рамках структур народного хозяйства. Путем подобного расчета можно количественно выразить отклонения пропорций какой-либо структуры выполнения плана от первоначально запланированных пропорций. Таким образом получается измеритель уровня нарушения структуры вследствие невыполнения намеченных в плане пропорций. Невыполнение запланированных пропорций имеер большое значение в народном хозяйстве, поскольку план не является совокупностью отдельных, изолированных объектов, а комплексным целым, в котором пропорции также запланированы.

Информация для контроля выполнения организационной нормы или наметки плана может быть измерена и таким путем могут быть выявлены необходимые заключения для принятия решений.