

CYBERNETICS AND COMMUNICATION

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Summary

Without a good, coordinated network of control and communication processes (CC), complex systems are not able to exist as a whole, and they disintegrate into dead components. This is the origin of Cybernetics and Communication (C&C). Designers of Life Support Systems (LSS) can use C&C as a conceptual tool to help them satisfy the demands of sustainable development (SD).

The development of C&C stemmed from the book *Cybernetics: or Control and Communication in the Animal and Machine*, which accentuated the generalized character of processes in the animal and the machine. However, it was made clear, little by little, that general notions such as goals, dynamics, stability, and attractors turned out to be insufficient for the description of the processes in living beings. This is because, in the case of machine, general notions are used as complementary ones to known specifications, such as construction, but in the case of living beings, the larger part of the microlevel construction and the laws of its development remained unknown. The nonlinear dependence of communication processes on the macro level, insufficiently investigated processes on the micro level, and the irreversibility of the set of processes enlarge the problems, just as the multi-aspect complexity of processes of communication in society and the possibility of ill-intentional manipulation of information raise problems for SD. Therefore, the methodology of studying CC is modified to ensure a more balanced consideration of the general and specific problems.

Although most attention is paid to the processes of CC on the social level, the role of the unconscious sphere, which brings together social and biological objects, is described,

too. The processes of communication that lead in the long term toward the irreversible reorganization of the architecture of the nervous system and the behavior of objects have attracted significant attention. The stabilization of these processes and strategies that can increase the harmony of social objects is considered.

1. Methodology

Consideration of cybernetics (see *Systems Science and Cybernetics*) as the science that studies the general principles of CC in the animal and the machine (see *History of Cybernetics*) has the merit and the shortcoming that it covers a wide class of study objects. Biological objects have significant differences from technical objects: both have their peculiarities of CC. To accentuate the differences, it is reasonable to designate general cybernetics after Wiener as cybernetics g, and cybernetics of biological objects as cybernetics b. Cybernetics g must be a component of cybernetics b, supplemented with a description of the nature of the distinctions between biological objects and technical objects, and with the peculiarities of CC that are specific to biological objects. Similarly, social cybernetics can be designated cybernetics s. It must be supplemented like cybernetics b, with a description of the nature of distinctions between social objects and biological ones, and with the peculiarities of CC that are specific to social objects. The methodological advantage of this approach provides an easier perception of the sequential increase of the complexity of cybernetic divisions.

The general system theory (see *General Systems Theory*) of CC, with its set of basic notions such as goal, attractor, trajectory, state, equilibrium, structure, dynamics, stability, productivity, is the division cybernetics g. These notions are used to describe the widest class of dynamic systems. Cybernetics g must be the core of all specific divisions. The set of notions of cybernetics b that is complementary to this core must be based on specific features of bio-objects and the general principles of CC. The main additional features of bio-objects are that they are open, self-organizing systems that are far from thermodynamic equilibrium, and that they have to support their stability by the constant consumption of specific organic forms of matter and energy.

The most important feature of bio-objects is their fitness. The notion of fitness is bound up with the necessity to ensure both the survival of oneself and the survival of descendants by reproduction in the specific external environment, with the evolution of bio-objects in the process of adaptation toward a changing environment. The next most important features of bio-objects are the multilevel architecture of their nervous system and the mechanism of its maturation directed toward support of their fitness on the set of spatiotemporal scales. Important additional features are microlevel influences on macrolevel behavior, the enormous number of nonlinear processes on all levels, the deep levels of architectural changes, including intracellular level, and the irreversibility of the many processes that direct organism maturation toward the different branches of their irreversible substates on all levels.

Cybernetics b must be the core of cybernetics s that is added with control peculiarities specific to social objects (systems). The specific features of the social objects are bound up with consciousness and language, the emergence of economic and organizational systems, the enormous growth of spatial scales of communications, and concentration of power and resources in the hands of small groups, using communications for

manipulation by people conscious of the purpose of increasing the fitness of the elite. Communication plays a key role in both decision making and in the maturation of the nervous system. The specific feature of social objects is a set of potential barriers bound up with language, education, profession, social position, and ethics, on the paths of communication.

The distinction between social and biological objects is not as large as the distinction between biological and artificial objects. Although consciousness originated on the level of homo sapiens, this species retained a vast unconscious sphere that was in dynamic equilibrium dependent on the environment of the sphere of consciousness. The preservation of the unconscious sphere ensures huge advantages and creates huge problems. The advantage is that a person does not need to control the large number of biological variables that are necessary to the homeostasis of the organism. The problem is that the unconscious sphere exceeds the limits of its competence from the point of view of the conscious; it defines more differences between the individual and the environment than would be optimal from the criteria of maximizing the fitness of population. Moreover, the unconscious level initiates some set of interactions realized with conscious participation. As a result, the individual has to exert every effort to realize and estimate his actions on the basis of consciously developed criteria. Impartial estimation of people's actions always leads to the same conclusion: the unconscious sphere, in most cases, directs the individual toward the growth of its own short-term fitness, instead of toward the growth of long-term fitness of the population. Naturally, this creates huge problems for achieving the purpose of SD, which cybernetics must help to overcome.

Sustainable Human Development claims that the principles of CC ought to be directed toward development, introduction, and support of the stability of new architecture, new adjustment of social systems, and new procedures of CC that are able to support the fitness of homo sapiens and the environment on a global, spatiotemporal scale, instead of supporting the fitness of local groups. CC principles need to be directed also toward development of a metasystem, ensuring:

- the change of the mentioned architecture—procedures of CC as knowledge is accumulated, and ethics are developed that will allow violations that destroy society to be dispensed with,
- the introduction of the mechanisms of development and correction ethics in the framework of metaethics (principles of justice, and of the growth of population fitness), because violation can originate on the basis of the chosen way of correction ethics if the mechanism of ethics support is introduced.

2. Communication between Man and Machine

The problems of information perception created by machine and man are different. In the first case, the features of the information source and messages are fully known; in the second case, they are not. In the first case, the problem of signal extraction from noise arises, instead of the problem of pattern recognition. All that was transferred inside the communication link, except for the noise, is considered to be information. In the second case, the problem is to understand which part of the message is the information, because one has to recognize the same message on the basis of different

features coordinated with situation. This means that only a small part of the flow of bits transferred into the channel carries real information, and this part is different in each situation.

Interface is a device that is used for the exchange of information between machine and man. The most important criteria for the development of interfaces are convenience for the user and minimum cost. When the key is the criterion of minimum cost, the interface is adapted toward the machine, and in fact the machine's methods of communication are used. As a result, simple interfaces such as a key, a mouse, or a joystick, which are designed to interact only with human hands, are developed. The whole flow of bits is considered information. The process of communication is considered completed after entering the mentioned flow as input into the smart interface, which is a special program. When the key is the criterion of convenience for the user, specific human signals such as speech and handwriting are used, and the problem is not only reproduction, but also the machine's adequate response. In this case communication is considered complete after the minimal, standard, realized signals, such as words and sentences, are recognized as the mechanisms for the purpose of conscious decision making. In this case it is not enough to recognize minimal standard unconscious signals such as phonemes or letters, because the conscious mind does not perceive them as its minimal objects, and a program that models only this brain function cannot perform necessary response. Thus, when directing attention toward natural signals, the notion of communication is extended. It claims the use of the mechanisms of pattern recognition that can recognize the objects accessible to consciousness. The algorithms of functioning of those mechanisms have to be bound up with functioning principles of the cortex centers, which create those messages. As a result, the software of those mechanisms is complex and expensive.

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Biographical Sketch

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