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D.A. Novikov

Cybernetics

From Past to Future

Springer

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*In warm memory of my father,
Academician A.M. Novikov, who opened up
the world of cybernetics to me*

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Introduction

> We had dreamed for years of an institution of independent scientists, working together in one of these backwoods of science, not as subordinates of some great executive officer, but joined by the desire, indeed by the spiritual necessity, to understand the region as a whole, and to lend one another the strength of that understanding. N. Wiener

The history of science development has *"romantic" periods*. One of them fell on the middle of the 1940s. "Romanticism" was determined by several factors.

The first factor concerned *an intensive flow of scientific and applied results*. Just imagine: the end of the terrible World War II (1945); dynamic growth of industry; the way out of the crisis in physics (which occurred at the beginning of the twentieth century)—the appearance and rapid development of atomic physics, quantum mechanics, general and special relativity theory, and astrophysics; first atomic bomb explosion (1945), followed by first atomic power plant launch (1954); electrical and radio devices usage by everymen; a series of discoveries in biology, physiology, and medicine (commercially produced (1941) penicillin (1928) saved millions of lives, the soon appearance of the three-dimensional DNA helix model (1953), rapid development of radiobiology and genetics, etc.); creation of first computer (1945) and bipolar transistor (1947); and the birth of choice theory [12] (1951), artificial neural networks (1943), game theory (1944–see [143, 145]), and operations research (1943), representing a striking example of an interdisciplinary synthetic science.

The second factor was associated with the comprehension of science *interdisciplinarity* by researchers from different branches. Interdisciplinarity implies that (a) there exist general approaches and regularities in different scientific branches and (b) it is possible to perform an *adapted translation of results* between some branches. This led to the obvious necessity of generalization search, not only within the framework of a certain field of knowledge or at a junction of fields, but (in the first place) at their "intersection." In other words, the matter was not even to create new paradigms in T. Kuhn's sense [112] for a branch, but to apply joint efforts of physicians and biologists, mathematicians, engineers and physiologists, etc., for obtaining fundamentally new results and breakthrough technologies.

The third factor was that the *role and "benefit" of science became evident for everymen and politicians*. The former enjoyed scientific results owing to their rapid and mass implementation. The latter (a) realized that science is an important public and economic drive of a society and (b) got accustomed to that project-based management of applied research allows predicting and in part guaranteeing its duration and results.

However, the flight of thought and stormy feelings of any romanticism go in parallel with *overestimated expectations*. Moreover, the onrush development of any science is inevitably followed by its normal advancement (e.g., according to T. Kuhn).

All these regularities fully affected *cybernetics*—a science born in the above "romantic period" (1948) and undergone romantic childhood, the disillusionment of juvenility and the decay of maturity.[1] The book discusses exactly these issues, representing a brief "navigator" across the history of cybernetics, its state of the art, and prospects. The style of a "navigator" implies renunciation of a detailed characterization of results: Numerous references cover almost all[2] classical works on cybernetics[3] published to date. On the other hand, such style a priori makes exposition somewhat incomplete, eclectic, and nonrigorous, as it would seem to a representative of any concrete science mentioned.

The book possesses the following structure. First, we consider the evolution of cybernetics (from N. Wiener to the present day), see Sects. 1.1 and 1.2. A detailed analysis focuses on the reasons of its ups and downs in Sect. 1.3. Next, we study the interrelation of cybernetics with *control philosophy* and *control methodology* (Chap. 2), as well as with *systems theory* and *systems analysis* (Chap. 4). Chapter 3 discusses the basic laws, regularities, and principles of control. Chapter 5 identifies some modern *development trends* of cybernetics. In the conclusion, we introduce the new stage of cybernetics development—the so-called *Cybernetics 2.0* as the science of systems organization and control. Appendices contain a list of basic terms and topics for self-study.

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[1]Note that general systems theory and systems analysis proceeded a similar path, see below.

[2]Cybernetics is a synthetic science and any attempt to give a comprehensive bibliography of its components (e.g., control theory) is doomed to failure. By saying "all," we mean cybernetics proper (Cybernetics with capital C as explained in Sect. 1.1).

[3]Most references are publicly available to an interested reader in Internet.