THE BEGINNINGS OF SECOND ORDER CYBERNETICS

S.A. Umpleby T.A. Medvedeva

George Washington University Siberian State Transport University

Washington, DC 20052, USA 191 D. Kovalchuk St., Novosibirsk, 630049, Russian Republic

Email: [umpleby@gmail.com](mailto:umpleby@gmail.com) E-mail: tmedvedeva@mail.ru

Received: 12/29/2021

ABSTRACT

The article discusses the emergence of second-order cybernetics based on work in experimental epistemology and the study of the nervous system, as well as the emergence of a new understanding of the cognitive process. Studies have shown that it is necessary to include a scientist-observer in the description of the system, since his or her specific characteristics and subjective worldview can influence the result of observation. The authors give examples of neurophysiological experiments that served as the basis for the conclusion that knowledge is a biological phenomenon, that each individual constructs his own "reality", which is consistent with the world of sensory experience, but is not identical to it. Two ways of understanding cybernetics of higher orders are considered. The first interpretation emphasizes that higher orders of cybernetics can be based on the introduction of additional dimensions (for example, second-order cybernetics relies on neurophysiology, third-order cybernetics takes into account data from sociology and political science, fourth-order cybernetics uses data related to the environment and social responsibility). The second interpretation is based on the opinion that there is no need for cybernetics of higher orders, since the observer himself can define any system of interest to him (for example, a group within an organization, society or the environment) and create any number of additional descriptions (H. von Förster ). The authors of the article conclude that second-order cybernetics offers a higher conceptual level by drawing attention to the scientist (observer). Second order cybernetics leads to second order science. It points to a suitable epistemology for an information society. The inclusion of the scientist (observer) in observations changes the epistemological foundation of science.

Key words: second order cybernetics, epistemology, knowledge, constructivism

THE ORIGIN OF CYBERNETICS

The birth of cybernetics as a scientific discipline in the United States is usually associated with the publication of two papers in 1943. Rosenblueth, Wiener, Bigelow, in “Behavior, Purpose, Teleology”, argued that goal-setting and purposeful human activity can be performed by machines specially created for this purpose. The authors of the second article, by Warren McCulloch and Walter Pitts, “A Logical Calculus of the Ideas Immanent in Nervous Activity,” suggested that ideas emerge through the activity of a neural network.

These articles stimulated the development of a scientific program for the design of machines that imitate certain types of human intellectual activity. The strategy of the scientific program was to study the nervous system, create of a formal theory of knowledge and use the theory to design intelligent machines.

After Norbert Wiener defined cybernetics in 1948, it attracted the attention of people working in various disciplines. Applications of these ideas have been developed for many systems: mechanical (James Watt), electrical (Norbert Wiener), biological (Walter B. Cannon), psychological (Warren McCulloch), political (Karl Deutsch), organizational (Stafford Beer), etc. How did scientists from such different disciplines come to understand the need to apply the ideas of cybernetics in their scientific fields?

In 1974, Heinz von Foerster explained this phenomenon using the term "second-order cybernetics" [Foerster 1974]. He drew on earlier work in the field of experimental epistemology by Warren McCulloch (1965), as well as work in mathematics by Norbert Wiener (1948). Common to all these areas of application is that they include two objects - the observer and the system observed, since it was found that the specific characteristics of the scientist/ observer and his subjective worldview can influence the results of observations.

In subsequent years, von Foerster, his colleagues and members of the American Society for Cybernetics tried to establish this new or updated concept of cybernetics, but these ideas did not have a strong impact on the broad scientific community.

NEUROPHYSIOLOGICAL FOUNDATIONS OF SECOND ORDER CYBERNETICS

The development of the basic idea of ​​second-order cybernetics took place in the works of von Förster (1981), E. von Glasersfeld (1987), H. Maturana and F. Varela (1987). They argued that knowledge is a biological phenomenon, that each individual constructs his own "reality" [Foerster 1974; 2003] and that knowledge is “consistent” with the world of sensory experience, but not “identical” to it [Glasersfeld 1987].

The basis for such conclusions was the neurophysiological experiments that were carried out by W. McCulloch, H. Maturana, F. Varela, and others. The “Blind Spot” experiment is widely known, demonstrating that local blindness is a consequence of the absence of photoreceptors. In another experiment, two kittens are placed in bags on a cart. One of them has its paws tucked in, while the other is standing. Then the cart is moved for several days. After that, the kittens are taken out of the bags and placed on a table. One kitten moves normally, the other walks off the edge of the table. The kittens are lowered to the floor. One of them walks normally, the other bumps into things as if he can't see anything. The kitten that was standing on the cart can see and move normally. The kitten that was not standing lacked depth perception [Held and Hein 1963].

There are many ways the brain helps us. For example, if we listen to a foreign lecturer delivering a lecture in our native language with an accent, then we must listen very intensely to understand this accent. However, after 10-15 minutes, the brain learns the algorithm, and we no longer must work so hard to understand the speaker.

One more example. During the war, soldiers were sometimes injured by high-velocity projectiles to the head but remained alive. The nature of these wounds was such that most lesions were well-localized occipital lesions in the brain that heal relatively quickly without the patient realizing any noticeable loss of vision. The doctors expected to see apparent motor disfunction. Clinical trials showed that the motor system was in order, but in some cases there was a significant loss of a large part of the visual field [Foerster 1973].

Doctors could not find an explanation for what was happening. But an incident occurred that helped in understanding the situation and in finding a way to treat the patients. One of the doctors came to his patient to ask a series of questions and wrote down the answers to them. During the conversation, the doctor put down his pen, took out a pack of cigarettes and invited the patient to smoke. The patient accepted the offer but did not reach for a cigarette. The doctor repeated the invitation to smoke again and held out the cigarette more insistently. The patient looked at the doctor inquiringly and asked where the cigarette was. The doctor replied that he held it in his hand. The patient said it was not there. The doctor asked what was in his hand. The patient replied, “a pen.”

The field of vision of the wounded soldiers was limited. When the doctor entered the room, the patient saw him in his peripheral vision, and thus the patient's brain gathered data about what was happening. But, when the patient looked at the doctor, the middle fell out of his field of vision, because there was a blind spot. The patient's brain constructed reality based on the data it already had.

A successful therapy was found. It consisted of blindfolding the patient for one to two months until he regained control of his motor system, switching his "attention" from "non-existent" visual cues to "fully working” channels that provide direct information from 'sensors' embedded in muscles and joints. Von Förster writes: “Let us once again note that the patients did not perceive the “lack of perception”, as well as the emergence of perception through sensory-motor interaction. This evokes two metaphors: "Perception is action" and "If I do not see that I am blind, I am blind, but if I see that I am blind, then I see" [Foerster 1973].

CONCLUSION

Second order cybernetics offers a higher conceptual level by drawing attention to the scientist (observer). The higher order refers to the scientist's act of observation. An observer can define any system of interest to him (for example, a group within an organization, a society, or an environment) and create any number of additional descriptions. The idea that each "order" of cybernetics is rooted in a separate theoretical discipline is one interpretation of second-order cybernetics, but it is important that second-order cybernetics requires a different level of analysis, a different philosophy, a different theory of knowledge, and not just a different theory.

Second order cybernetics leads to second order science. If physics is a fundamental field that describes the relationship between matter and energy, then cybernetics is a fundamental field that describes control and communication. Physics became the basis of industrial society. Cybernetics provides the basis for an information society. Second-order cybernetics points to a suitable theory of knowledge for an information society. The inclusion of a scientist (observer) in descriptions changes the epistemological foundation of science. The epistemology of realism is supplemented by the epistemology of constructivism in the works of some scientists in the USA and Europe.

REFERENCES

Beer, Stafford (1995) Brain of the Firm, 2nd edition, Wiley.

Cannon, Wal B. (1963) The Wisdom of the Body, W.W. Norton & Company, New York.

Deutsch, Karl (1963) The Nerves of Government: Models of Political Communication and Control, Free Press.

Foerster, Heinz von (2003) “On Constructing a Reality”, Understanding Understanding: Essays on Cybernetics and Cognition, Springer, New York.

Foerster, Heinz von (1981) Observing Systems, Intersystems.

Foerster, Heinz von (ed.) (1974) Cybernetics of Cybernetics, Future Systems, Minneapolis (MN).

Glasersfeld, Ernst von (1987) The Construction of Knowledge, Intersystems, Salinas (CA).

Held, Richard M. and Hein, Alan (1963) “Movement Produced Stimulation in the Development of Visually Guided Behavior”, Journal of Comparative and Physiological Psychology, Vol. 56 (5), pp. 872–876.

Maturana, Humberto R., Varela, Francisco J. (1987) The Tree of Knowledge, New Science Library.

McCulloch, Warren (1965) Embodiments of mind, MIT Press, Cambridge (MA).

McCulloch, Warren, Pitts, Walter (1943) "A Logical Calculus of the Ideas Immanent in Nervous Activity.” Bulletin of Mathematical Biophysics, 1943, Vol. 5, pp. 115–133, MIT Press, Cambridge (MA).

Rosenblueth, Arturo, Wiener, Norbert, Bigelow, Julian (1943) “Behavior, Purpose, Teleology”, Philosophy of Science, 1943, Vol. 10, pp. 18–24.

Wiener, Norbert (1948) Cybernetics or Control and Communication in the Animal and the Machine, MIT Press, Cambridge (MA).

Author's Information

UMPLEBY Stuart Anspach -

PhD, professor at George Washington University, Washington DC, USA.

MEDVEDEVA Tatyana Alekseevna -

Doctor of Economics, Professor, Siberian State University of Transport, Novosibirsk, Russian Federation.

DOI: 10.21146/0042-8744-2021-?-???-???

Citation: Amplebi S.A., Medvedeva T.A. Beginnings of second-order cybernetics // Questions of Philosophy. 2022. No. 8. S. ?–?