Stuart A. Umpleby, Tatiana A. Medvedeva & Vladimir Lepskiy "Recent Developments in Cybernetics, from Cognition to Social Systems", Cybernetics and Systems, 2019. Volume 50, Issue 4, pp. 367-382. https://doi.org/10.1080/01969722.2019.1574326

RECENT DEVELOPMENTS IN CYBERNETICS, FROM COGNITION TO SOCIAL SYSTEMS

Stuart A. Umpleby, Tatiana A. Medvedeva & Vladimir Lepskiy

May 20, 2018

Prepared for publication in *Cybernetics and Systems*

RECENT DEVELOPMENTS IN CYBERNETICS, FROM COGNITION TO SOCIAL SYSTEMS

Stuart A. Umpleby, The George Washington University, Washington, DC, USA

Tatiana A. Medvedeva, Siberian State University of Transport, Novosibirsk, Russia

Vladimir E. Lepskiy, Institute of Philosophy, Russian Academy of Sciences, Moscow, Russia

Abstract. This article consists of three parts. In the first part we describe a short history of cybernetics and an effort, which has been undertaken by a group of scientists in the United States and Europe in recent years, to expand the conception of science so that it more successfully encompasses the social sciences. The intent is to aid communication among disciplines and improve our ability to manage social systems. The second part of the article presents an effort in Russia to develop reflexivity theory into a general theory of purposeful, self-developing systems, thus improving our understanding and management of social systems. Understanding Western and Eastern approaches to cybernetics can be difficult because of the very different histories and intellectual traditions of cybernetics in the United States and Russia. The article ends with a comparison of the two approaches to cybernetics, comparing their features side by side. The differences suggest a great potential for ideas from Russian and Western scientists to enrich the further development of cybernetics and science in East and West.

Key words: expanding science; cybernetics; second-order cybernetics; third-order cybernetics; social systems; intellectual traditions.

Expanding the Conception of Science

The field of cybernetics emerged in the late 1940s during a series of conferences in New York City sponsored by the Josiah Macy Jr. Foundation. During World War II many scientists had worked on applied projects. After the war they wanted to discuss what they had learned. Ten conferences on the theme of "Circular Causal and Feedback Mechanisms in Biological and Social Systems" were held between 1946 and 1953. They were chaired by Warren McCulloch, a philosopher at MIT [Abraham, 2016]. Participants included Gregory Bateson, Margaret Mead, Norbert Wiener, John von Neumann, Heinz von Foerster, Ross Ashby, Kurt Lewin and others [Pias, 2003]. After Wiener published his 1948 book, *Cybernetics, or Control and Communication in the Animal and the Machine*, the meetings were called the Macy Conferences on Cybernetics.

McCulloch was a philosopher who wanted to understand cognition. He decided to test existing theories of knowledge from philosophy using experiments in neurophysiology. McCulloch [1965], Humberto Maturana [1975], Heinz von Foerster [2003] and others asked, "How does the brain work?" One conclusion was that observations independent of observers are not physically possible. Building on the empirical work, von Foerster sought to include the observer within science. In 1974 he invented the term "second order cybernetics," in an effort to shift the focus of attention in cybernetics from technical applications to the study of cognition [Foerster, 2003].

Several definitions of first and second order cybernetics have been given. See Table 1 [Umpleby, 2016]. A group of people in the American Society for Cybernetics thought this was important work and wanted to advance second order cybernetics as a scientific revolution within the field of cybernetics [Umpleby, 1974]. Beginning in the late 1970s this group began giving tutorials about the history and fundamentals of cybernetics at conferences in the U.S. and Europe.

Tutorials were necessary because of the lack of university courses and degree programs in cybernetics. After presenting papers and tutorials at conferences for several years, they asked, "How does a scientific revolution end? How does one know the revolution has succeeded?" Thomas Kuhn had said there were periods of normal science and periods of revolutionary science [Kuhn, 1962]. He emphasized the transition from normal science to a revolutionary period due to "incommensurable definitions." A revolutionary period ends, Kuhn believed, when the younger generation decides to adopt the new point of view. But could there be a more definitive sign? Perhaps the Correspondence Principle would help. See Figure 1.

The Correspondence Principle was proposed by Niels Bohr [1913] when developing the quantum theory. It says, "Any new theory should reduce to the old theory to which it corresponds for those cases in which the old theory is known to hold." Wladyslaw Krajewski in a book on the Correspondence Principle [1977] expressed the view that a more general theory is not sufficient. There should also be a new dimension that was previously not noticed or had been thought to be insignificant. So, how could the role of the observer be formulated as a new dimension?

Table 1 – Definitions of First and Second Order Cybernetics

Author	First Order Cybernetics	Second Order Cybernetics
Von Foerster	The cybernetics of observed systems	The cybernetics of observing systems
Pask	The purpose of a model	The purpose of the modeler
Varela	Controlled systems	Autonomous systems
Umpleby	Interaction among the variables in a system	Interaction between observer and observed
Umpleby	Theories of social systems	Theories of the interaction between ideas and society

Source: [Umpleby, 2016]

Figure 1. How science advances

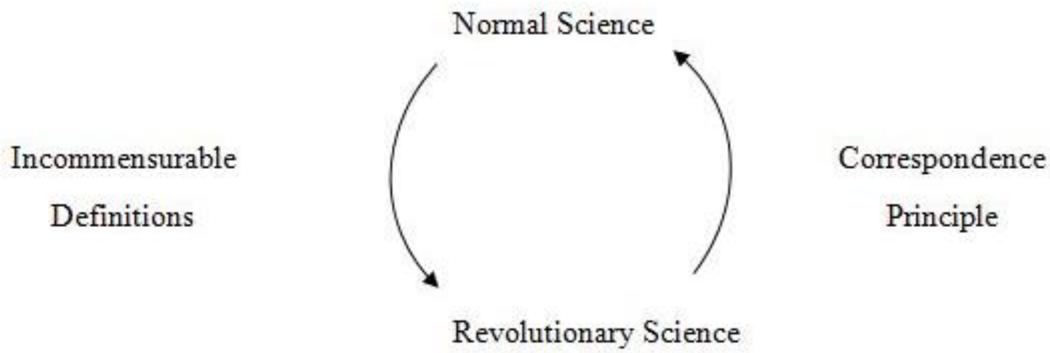
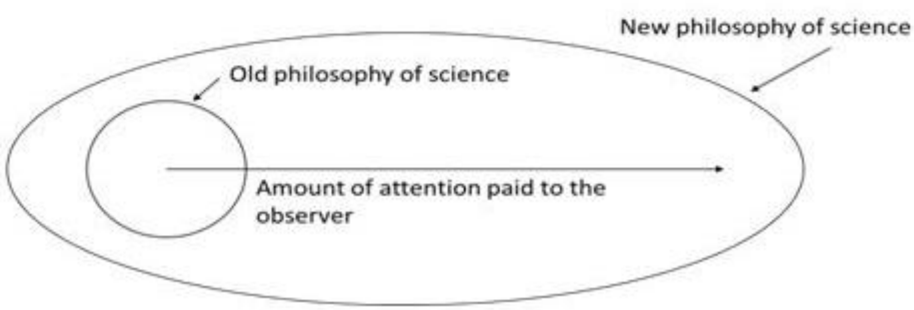


Figure 2. Expanding science in accord with the Correspondence Principle



The new dimension would be something that was not previously considered (e.g., the speed of light in relativity theory) or was assumed to be insignificant (e.g., the diameter of molecules in the gas laws). See Figure 2 [Umpleby, 2014]. All the data that supported the old theory (i.e., small circle) would also support the new theory (i.e., large oval). But now many more experiments could be conducted to investigate the region created by the new dimension (the area inside the large oval).

As more social scientists were attracted to the field of cybernetics, more thought was given to social systems. One way to describe the development of cybernetics is to say that it has progressed through three stages – engineering cybernetics, biological cybernetics and social cybernetics. See Table 2 [Umpleby, 2014]. These three approaches to cybernetics can be arranged in a triangle using Karl Popper's three worlds [Popper, 1978]. In Figure 3 the left side of the triangle would be the positivist approach to science. Scientists create descriptions of the world. The observer is explicitly excluded due to a desire to be objective. Biological cybernetics is concerned with how the brain creates descriptions of the world. Little attention is paid to the world since it already is included in the perceptions of the observer. Social cybernetics is concerned with how people act in the world. Theories or descriptions are thought to be less important than appropriate actions. Hence, each side of the triangle emphasizes two vertices and deemphasizes the third. Second order cybernetics was first a theory of knowledge (bottom of the triangle) and later also a description of how knowledge is used (right side of the triangle). With this triangle second order cybernetics became not a competing epistemology to positivism but a theory of epistemologies [Umpleby, 2016].

For many decades social scientists have tried to imitate the physical sciences. Physics was regarded as an example of how to do science. More recently the idea is to expand science so the physical sciences become a special case of a larger view of science. The new view includes purposeful systems. Inanimate objects (e.g., in physics) are a special case [Umpleby, 2017].

Second Order Cybernetics

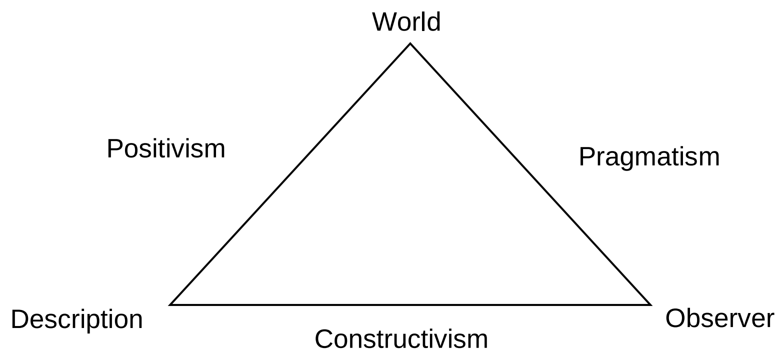
In recent years there has been a transition from speaking about second order cybernetics to describing also second order science [Riegler & Mueller, 2014, Mueller, 2011, Kauffman, 2016]. This is possible because cybernetics is a general theory of control and communication. It is a theory of information and regulation. Physics, in contrast, is a general theory of matter and energy.

Table 2 - Three versions of cybernetics

	Engineering Cybernetics	**Biological Cybernetics**	**Social Cybernetics**
The view of epistemology	A realist view of epistemology: knowledge is a "picture" of reality	A biological view of epistemology: how the brain functions	A pragmatic view of epistemology: knowledge is constructed to achieve human purposes
A key distinction	Reality vs. Scientific Theories	Realism vs. Constructivism	The biology of cognition vs. the observer as a social participant
The puzzle to be solved	Construct theories that explain observed phenomena	Include the observer within the domain of science	Explain the relationship between the natural and the social sciences
What must be explained	How the world works	How an individual constructs a "reality"	How people create, maintain, and change social systems through language and ideas
A key assumption	Natural processes can be explained by scientific theories	Ideas about knowledge should be rooted in neurophysiology	Ideas are accepted if they serve the observer's purposes as a social participant
An important consequence	Scientific knowledge can be used to modify natural processes to benefit people	If people accept constructivism, they will be more tolerant	By transforming conceptual systems (through persuasion, not coercion), we can change society

Source: [Umpleby, 2014]

Figure 3. Three epistemologies



Whereas the physical sciences describe the material world, cybernetics is concerned with purpose, meaning, regulation, understanding and ways of knowing, including science. Hence, cybernetics aspires to provide a general theory of management, government, the interaction between ideas and society, and perhaps even the history and philosophy of science. The result has been an attempt to expand the conception of science so that it more adequately encompasses social systems. Social systems are reflexive. They observe, reflect and act. And they are composed of elements (e.g., individuals and organizations) that are also reflexive [Lefebvre, 1982; Soros, 1987; Umpleby, 2017]. Trying to describe social systems using tools taken from the physical sciences is very limiting. An alternative is to begin with an understanding of the phenomenon of interest.

Recent work in cybernetics has suggested that three dimensions can be added to our conception of science, not just to cybernetics.

1. The observer should be included in descriptions. We need to understand not only how to conduct an experiment but also the background of the scientist – history and culture, field of study, perhaps religion and political perspectives – any conceptions of the world that shape the context and the purpose of an inquiry.
2. In the physical sciences theories do not alter the way the world works, except to some extent in quantum mechanics. But in the social sciences there is a dialogue between theories and practice. A social theory typically describes how a social system operates and is used to suggest actions that might improve its performance. The evolution of economic thought provides an example. Theories by Adam Smith, Karl Marx, John Maynard Keynes, and Milton Friedman not only describe economic systems but also influence the way people behave in social systems [Umpleby, 2014].

3. The history of science is a self-organizing system, similar to biological evolution. There are two processes – the creation of new variety (e.g., the creation of a new theory) and the selection of appropriate variety [Ashby, 1962] . Some ideas are adopted and used. Some ideas are discarded. In the philosophy of science emphasis is placed on testing ideas. How ideas originate, or where they come from, is not necessarily described. New ideas are thought to arise from intuition, imagination, or inspiration. However in recent years schools of design have been created at several universities. They are usually in schools of art or architecture. But machines, software, management procedures and government programs are also designed. There are now methods for teaching design. Hence there are now methods for creating hypotheses as well as methods for testing them.

These three additions to science – including attention to the observer or scientist, considering the effect that theories have on the phenomenon described, and methods for creating new hypotheses – are significant additions to our conception of science. They are consistent with earlier scientific work and they expand the possibilities for science in the future. Hence, they are consistent with the Correspondence Principle. In the new conception of science physics is not an example for all of science but rather a special case of a larger conception. The new conception will aid the unification of the sciences, both natural sciences and social sciences.

Third order cybernetics

Vladimir Lepskiy and his colleagues at the Institute of Philosophy of the Russian Academy of Sciences have been meeting every two years for about 20 years to discuss Reflexive Processes and Control. They now call their work "third order cybernetics." [Lepskiy, 2018].

The idea of third order cybernetics is based on the idea that philosophy of science is passing through three stages: classical, non-classical, and post-non-classical. [Stepin, 2005]. Each of the three development stages of science are associated with the dominance of one of three types of scientific rationality - classical, non-classical and post-non-classical rationalities. The scientific rationalities are not alternatives. Each subsequent rationality has its own features but includes also the previous types of rationality. Post-non-classical scientific rationality integrates all three types of scientific rationality.

The classical type of scientific rationality concentrates attention on the object and, in theoretical descriptions and explanations, tends to eliminate everything that refers to the subject, or the means and operations of the research activity. This elimination is regarded as a necessary condition for obtaining objectively true knowledge of the world. The goals and values of science, the strategies of investigation and the methods of analyzing the world, at this stage, as well as at all other stages, are determined by the worldview, attitudes and value orientations dominant in the culture. But classical science does not comprehend these determinations.

The non-classical type of scientific rationality takes into account connections between the knowledge of objects and the means and operations of research activity. For an adequate interpretation of knowledge, a clear presentation of the research tools is necessary. This approach is relevant for both physical and social studies. In this approach to research there is a transition from the domination of positivism to philosophical constructivism which becomes one of the leading directions within non-classical rationality. In such relations the researcher becomes only one person in the specific system of reflexive relations. This research has created the basis for a transition from the paradigm of "*subject – object*" to the paradigm of "*subject – subject*".

The post-non-classical type of scientific rationality broadens the amount of reflexion on activity. It takes into account the knowledge obtained about the object, the means and operations of research activity, and also the value-goal structures of the people and institutions conducting the research. Here we explicate the connection between intra-science goals and extra-scientific social values and goals, in this type of scientific rationality the convergence of internal and external approaches to science is being addressed. In the context of this rationality attention is focused on harmony among causal (cause and effect) and teleological (target determination) approaches. In post-non-classical scientific rationality there is a transformation of philosophical constructivism. It becomes "softer". Freedom is thought of as establishing an equal partnership with what is outside the person: with natural processes, with other persons, with the values of other cultures, and with social processes. This new understanding of the person and natural relations provides a new foundation -- not anthropocentrism but joint evolution.

This comparison of the evolution of cybernetics and the evolution of scientific rationality leads to the hypothesis of their correlation. First-order cybernetics, "*cybernetics of observed systems*," (Norbert Wiener) developed within classical scientific rationality. Second-order cybernetics, "*cybernetics of observing systems*," [Foerster, 1973] developed in non-classical scientific rationality. Post-non-classical scientific rationality can become a basis for formation of post-non-classical “*cybernetics of self-developing reflexive-active environments*” [Lepskiy, 2018] which can be considered as third-order cybernetics. The idea of self-developing reflexive-active environments was created under the influence of the following interdisciplinary ideas and concepts. Philosophy, sociology and psychology have given us the ideas of post-non-classical scientific rationality, which integrates concepts of various scientific schools [Stepin, 2005], ideas of the noosphere [Vernadsky, 2007], the concept of society as a social system [Luhmann, 1995], the activity approach and subject-activity approach of Russian psychology [Leontiev, 1978; Vygotsky, 1981; Rubinshteyn, 1997] and studies by the Russian methodologists [Shchedrovitsky, 2002].

The results of the first steps on the path to formation of third-order cybernetics are presented in Table 3.

Table 3 - The generalized results of the philosophical and methodological analysis of the evolution of cybernetics (philosophical, methodological and theoretical levels)

PHILOSOPHICAL LEVEL		**METHODOLOGICAL LEVEL**		**THEORETICAL LEVEL**
Type of scientific rationality	**Philosophical approach**	**Paradigms or model**	**Scientific approach**	**Areas of knowledge**
Classical	Positivism	Subject - Object	Activity approach Monodisciplinary approach	Cybernetics
Non - classical	Philosophical constructivism	Subject - Subject	Subject-activity approach Interdisciplinary approach	Second order cybernetics
Post - non - classical	Humanistic interpretation of philosophical constructivism	Subject - Meta-Subject Self-developing reflexive-active environments	Subject-focused approach Transdisciplinary approach	Third order cybernetics (post-non-classical cybernetics of self-developing reflexive-active environments)

Source: [Lepskiy, 2018]

The formation of scientifically ensured control and cybernetics in the context of post-non-classical rationality has begun [Lepskiy, 2015]. The formation of post-non-classical third-order cybernetics is being realized. Thus, the main thesis would be *from "observed systems" to* "*observing systems"* to "*self-developing reflexive-active environments"*. From the paradigm *"subject - object"* to the paradigm *"subject - subject"* and further to the paradigm *"subject - metasubject"*.

A transition in control to the paradigm "subject – metasubject" led to the formation of new types of control. Control through self-developing environments becomes dominant. Control of "the soft force", control of chaos, control of complexity, control via "mechanisms of functioning of the environment", control "via mechanisms of assembly of subjects" and many other types of control. Control through self-developing environments is used to control economic systems. For example, the 2007 Nobel Prize in Economics [Hurwicz, 1972], was for research on the paradigm "subject - polysubject environment" in the control of economic systems.

Including the person in dynamic models of social systems is becoming a standard approach. For example, the 2002 Nobel Prize in Economics was awarded to Vernon L. Smith [2000] *"*for having established laboratory experiments as a tool in empirical economic analysis, especially in the study of alternative market mechanisms*"*. Most likely this is a double interpretation of the subject, as a built-in observer and as an active model of social processes.

Knowledge in third-order cybernetics

Let us consider several aspects of knowledge representation in post-non-classical scientific rationality.

Knowledge and a problem of subjectivity loss in "the digital world". One approach is to look for an adequate organization of interaction of the subject with the self-developing reflexive-active environment which should include various reflections on the acts and texts and should have some attributes of subjectivity itself. The metasubject should contain mechanisms of support for assembling the subjects included. The principle of the double subject is important [Lepskiy, 1998]. This principle determines the most important technological procedures for interaction of subjects with social systems in the digital reality. The principle of the double subject can be interpreted as the dynamic transformation of subjects into a virtual group subject based on the integration of natural and artificial intelligence.

The connection of subjects with the metasubject becomes the basis for project identification, consolidation of society for the implementation of strategic projects, and the development of democracy. There are opportunities for harmony among hierarchical, network and environmental mechanisms. It is important to note that freedom of the individual in choosing the degree of his participation in social processes is preserved.

The problem of active knowledge in a self-developing reflexive-active environment. The ocean of knowledge becomes less visible and available when viewed through traditional forms of access to knowledge. The solution for this problem is connected with the organization of active knowledge. Knowledge must possess the properties of artificial subjects. This is provided for by the principle of the double subject, which provides exteriorization in the digital reality of various forms of subjects' activity (activity, communication, reflexivity).

These environments permit combinations and interactions of the subjects in various forms of natural and artificial intelligence. The environments of active knowledge will allow satisfying not only the property of relevance (compliance of the information obtained to the inquiry formulated by the user), but also pertinence (compliance of knowledge gained by the user to his/her requirements). Creation of the environments of active knowledge assumes participation of people in the environments in the solution of the problem of implicit (personal) knowledge identification.

Integration of knowledge in self-developing reflexive-active environments. These environments provide integration of individual, corporate and social knowledge on the basis of the system of special ontologies (maintenance, support, development, designing, providing innovations) [Lepskiy, 1998].

Ethics in third-order cybernetics

The dominant concern in third-order cybernetics is ethical treatment of the subjects included in any meta-subject (a family, group, organization, country, etc.), the scientist's identification of himself/herself with this meta-subject and regulating interaction while taking into account his/her influence on the meta-subject. Such an approach to ethical regulators can have both positive and negative consequences. Positive consequences are connected with identification and assembly of subjects of development in mega-subjects as complete entities. Negative consequences are a possibility to lead to totalitarian social systems. It is a complex scientific problem which can be solved by integration of various types of scientific rationality on the basis of the adequate organization of self-developing reflexive-active environments [Lefebvre, 1982; Lepskiy, 2016].

Creating a Reflexive Philosophy of Government: An American interpretation of third order cybernetics as it has developed in Russia

The idea of third order cybernetics is rooted in the development of philosophical thinking in Russia in recent years [Lepskiy, 2015]. Whereas second order cybernetics emphasized self-reference and a scientist's reflection on his or her understanding, third order cybernetics is the study of social systems or the study of how a system composed of reflexive systems can itself be reflexive. An example is the relationship between a society and its government. The role of government is to enable a society to achieve its purposes, at a minimum survival and ideally prosperity and thriving. Achieving these objectives requires that the government control at least some aspects of society and that the society control the government, primarily by limiting the power that the government has over its citizens. Limits take the form of laws and institutions, such as a legislature and courts.

An important concept in third order cybernetics in Russia is the idea of a meta subject. The meta subject can be thought of on three levels. At the micro level the meta subject would be the family or the work group. At the meso level the meta subject would be a company or a city. At the macro level the meta subject would be a country or the world.

At the micro level the fields of psychology, therapy, and sociology have been influenced by cybernetics. Key authors are Gregory Bateson [1972], Donald Jackson, Paul Watzlawick [1967, 1986, 2011] and John Weakland.

At the level of the firm or organization the fields of management and public administration have also been influenced by cybernetics and systems science, for example Stafford Beer (1972), Russell Ackoff [1981], Peter Checkland [1999], and Markus Schwaninger [2008].

Well-developed theories of the behavior of small groups and business organizations are not much more than 100 years old. However, at the macro level to find the key authors one must go farther back in time. Theories of how to govern a society have a longer history, for example early legal systems [Hammurabi, 1955] and military handbooks [Sun-tsu, 2001]. In the 17^{th} century people in Europe were trying to create self-governing societies. The task was to build a reflexive society, one in which citizens were both rulers and ruled. Eventually the goal became to go beyond both the King and the Pope. Both still exist, but they are not as powerful as before.

The macro level is the most reflexive level. There are many feedback loops in a large social system. There are many challenges – how to resolve internal conflicts, how to defend the society against interference from outside, how to create an innovative society and how to achieve steady social progress in terms of standard of living and civil liberties.

Here are a few of the key steps in the development of government institutions in Europe. Charlemagne was crowned Holy Roman Emperor by the Pope in 800. His reign advanced the spread of Christianity in Europe. In 1215 the Magna Carta was the first agreement to limit the power of a king. Martin Luther (1483-1546) initiated the Protestant Reformation, thus limiting the power of the Pope. In the thirty years war (1618 – 1648) about 1/4 of the people in Europe were killed in wars between Protestants and Catholics.

During the 30 years war many people moved from Europe to North America to escape the religious conflicts. The Peace of Westphalia, that ended the 30 years war, supported the idea of religious freedom and largely created the conception of the nation state. Each country could choose its own religion. Each person could worship as he or she chose. Individuals and nations became self-governing.

The underlying problem in Europe was aristocracy and a class system. A political/ religious hierarchy was the idea that supported the aristocracy. There were two solutions. One could move to America and create a new society on the frontier. Or one could think one's way out of the box by inventing ideas like individual rights, a social contract, and the rule of law. Ideas developed in Europe were tested in North America. Leading theorists were Thomas Hobbes (1588-1679) and John Locke (1632-1704) in England, Voltaire (1694-1778) and Jean-Jacques Rousseau (1712-1778) in France and Edmund Burke (1729-1797) in Ireland.

According to Acemoglu and Robinson [2012] there are two challenges in developing a government: first, assembling enough power to achieve social purposes and second, limiting the power of the executive so that the rights of individuals are not abused. Over time several institutional arrangements have been developed, including (1) a federal system with local, state and national governments and (2) legislative, executive and judicial branches at each level. The branches are independent and each can check the power of the others. Other institutions are universities, a free press, business organizations, labor unions, and non-governmental organizations.

Several principles or values became accepted over time: majority rule and minority rights, a right to private property, trial by jury, the right of an accused person to have a lawyer, religious liberty, freedom of speech. Gradually secular authority replaced religious authority. The state – the citizenry as a whole through a constitutional system – developed the power to regulate both religion and the economy.

The type of government in a society is influenced by geography [Diamond, 2005]. A country with strong borders (e.g., UK and US) worries less about what people say and do. A country with no clearly defined borders (e.g., on the Central European Plane) must keep control of the population in order to repel invaders.

During the Cold War there were basically two points of view – capitalism and communism. These ideologies gave meaning and purpose to life and provided organizing principles. An alternative, more general point of view is what Karl Popper [1957] called “piecemeal social engineering” and what Donald T. Campbell [1988] called an “experimenting society.” If third order cybernetics is seen as a theory of experimentation and reform in social systems, it will connect work in cybernetics with political reform and the evolution of society. This is an important addition to cybernetics and to the unification of science.

Some conclusions: Comparison of Russian and American approaches to cybernetics from the perspective of intellectual traditions

Understanding the differences in intellectual traditions leads us to a deeper understanding of the theories of cybernetics. Western scholars single out cybernetics of the first and second orders. Cybernetics of the second order includes a biological and social version. It arose from "experimental epistemology." The goal was to understand the processes of cognition through neurophysiological experiments. As a result of these experiments cyberneticians came to the conclusion that the observer cannot be excluded from science.

The Russian interpretation of second-order cybernetics is different from the Western conception. Table 4 presents a description of Lepskiy's theory using Umpleby's criteria.

The development of the conception of third-order cybernetics is based on Russian ideas: the activity approach, the typology of scientific rationality, the inclusion of the moral component, and acceptance of irrationality, etc. These ideas are not well known in the West, which leads to some misunderstanding of concepts.

Briefly, the main differences between American and Russian approaches to cybernetics are the following:

- the American version of second order cybernetics includes biological and social versions; the development of cybernetics takes place within the framework of the paradigms of classical and non-classical rationality (using Russian terms);
- the Russian version of second order cybernetics excludes from consideration the biological version. In fact it reduces second order cybernetics to the cybernetics of the individual subject (observer) and, indirectly, his / her values (through the choice of methods and means of studying an object), in contrast to the third-order cybernetics concept with its focus on the social system (meta subject);

- Western scholars do not consider third-order cybernetics to be necessary, since the inclusion of an observer (subject) in the field of science, from their point of view, solves the problem of taking social values and goals into consideration [Medvedeva, Umpleby, 2003];
- V. Lepskiy's theory of third-order of cybernetics develops in the direction of typically Russian ideas: "noosphere", "collective consciousness", "co-evolution", etc., i.e. it is not just social cybernetics, but cybernetics of environments, and probably one can say cybernetics of nature.

Table 4 – Description of V.E. Lepskiy's theory using S.A. Umpleby's criteria

	1st order cybernetics	**2d order cybernetics**	**3d order cybernetics**
Leading scientific paradigm	Subject – Object	Subject – Subject	Subject – Meta Subject
The dominant approach	Activity approach	Subject-activity approach	The subject-oriented approach
Type of scientific rationality	Classical type of scientific rationality	Non-classical type of scientific rationality	Post-non-classical type of scientific rationality
The view of epistemology	A realist view of epistemology: knowledge is a "picture" of reality	Knowledge depends on the methods and means that the subject (observer) of the activity uses	Knowledge depends on the meta subject and its values, goals (meta-observer: family, group, organization, country, etc.)
A key distinction	Reality vs. Scientific Theories	Positivism vs. philosophical constructivism	Positivism vs. Humanistic constructivism; Emphasis on communication processes
The puzzle to be solved	Construct theories which explain observed phenomena	Include the observer within the domain of science	Reconcile intrascientific and social values and goals with the value orientations of the subject (observer) of scientific activity
What must be	How the world works	Reflection as a new	How the self-developing reflexive active environment

explained		dimension	works
A key assumption	Natural processes can be explained by scientific theories	The subject's goals and values are included through the choice of methods and means of studying the object and the assumptions made	Freedom as acceptance
An important consequence	Scientific knowledge can be used to modify natural processes to benefit people	Scientific knowledge can influence the phenomenon being studied	Scientific knowledge can be used to implement the idea of co-evolution: the coordinated evolution of nature and humanity as equal partners

Source: [Medvedeva, 2017]

The different descriptions of cybernetics demonstrate the great potential for ideas from Russian and Western scientists to enrich the further development of cybernetics and science in East and West. Such cooperation is increasing. In September, 2020 the Institute of Philosophy of the Russian Academy of Sciences plans to host the Congress of the World Organization for Systems and Cybernetics (WOSC2020).

References

Abraham, Tara H.. *Rebel Genius: Warren S. McCulloch's Transdisciplinary Life in Science*. Cambridge, MA: MIT Press, 2016

Acemoğlu, Daron, and James A. Robinson. *Why Nations Fail: The Origins of Power, Prosperity, and Poverty*. New York, NY: Crown Publishers, 2012.

Ackoff, Russell Lincoln. *Creating the Corporate Future: Plan or Be Planned for*. New York, NY: J. Wiley, 1981.

Ashby, W. Ross. "Principles of the Self-Organizing System." In *Principles of Self-Organization: Transactions of the University of Illinois Symposium*, edited by Heinz Von Foerster and G. W. Zopf, Jr., 255-78. London, UK: Pergamon Press, 1962.

Bateson, Gregory. *Steps to an Ecology of Mind*. New York: Chandler, 1972.

Beer, Stafford. *Brain of the Firm: A Development in Management Cybernetics*. New York: Herder and Herder, 1972.

Bohr, Niels. “On the Constitution of atoms and molecules.” *Philosophical Magazine*, 26,1913, 1-25, 476-502, 857-75. See also Volume 3: The Correspondence Principle (1918–1923). In *Collected Works*, edited by J. Rud. Nielsen and Leon Rosenfeld, 241-82. Amsterdam: North-Holland, 1976.

Campbell, Donald T., and E. Samuel. Overman. *Methodology and Epistemology for Social Science: Selected Papers*. Chicago, IL: University of Chicago Press, 1988.

Checkland, Peter. *Systems Thinking, Systems Practice*. New York, NY: John Wiley, 1999.

Diamond, Jared M. *Guns, Germs, and Steel: The Fates of Human Societies*. New York, NY: Norton, 2005.

Foerster, Heinz Von. "On Self-Organizing Systems and Their Environments." In *Self-Organizing Systems*, edited by S. C. Yovits and S. Cameron. Pergamon Press, 1960. http://e1020.pbworks.com/f/fulltext.pdf.

Foerster, Heinz Von. “On Constructing a Reality.” In Preiser F.E. (ed.) *Environmental Design Research*, 2, 1973, 35-46.

Foerster, Heinz Von. *Understanding Understanding*. New York, NY: Springer, 2003.

Hammurabi, King of Babylonia. *The Babylonian Laws*. Edited by G. R. Driver and John C. Miles. Oxford, UK: Clarendon Press, 1955.

Hurwicz, Leonid. "On Informationally Decentralized Systems." In *Decision and Organization*, edited by Radner and McGuire. North-Holland, 1972.

Kauffman, Louis H. "Cybernetics, Reflexivity and Second-Order Science." *Constructivist Foundations* 11, no. 3, 2016, 489-504. http://www.univie.ac.at/constructivism/journal/articles/11/3/489.Kauffman.pdf.

Krajewski, Władysław. *Correspondence Principle and Growth of Science*. Boston, MA: Reidel, 1977.

Kuhn, Thomas S. *The Structure of Scientific Revolutions*. Chicago: University of Chicago Press, 1962.

Lefebvre, Vladimir A. *Algebra of Conscience: A Comparative Analysis of Western and Soviet Ethical Systems*. Dordrecht: D. Reidel Publishing Comp., 1982.

Leontiev, Aleksej N. *Activity, Consciousness and Personality*. Englewood Cliffs, NJ: Prentice-Hall, 1978.

Lepskiy, Vladimir. *The Concept of Subject-Oriented Computerization of Control Activity*. M.: Institute of Psychology RAS, 1998.

Lepskiy, Vladimir. "Evolution of Concepts about Control." *Methodological and Philosophical Analysis*, 2015.

Lepskiy, Vladimir. "Ethical Models of V.A. Lefebvre in the Context of Development of Scientific Rationality." *Philosophical Sciences* 8 (2016): 40-53.

Lepskiy, Vladimir. "Evolution of Cybernetics: Philosophical and Methodological Analysis." *Kybernetes* 47, no. 2 (2018): 249-61. doi:10.1108/k-03-2017-0120.

Luhmann, Niklas. *Social Systems*. Stanford: Stanford University Press, 1995.

Maturana, H. R. "The Organization of the Living: A Theory of the Living Organization." *International Journal of Man-Machine Studies* 7, no. 3 (1975): 313-32.

Medvedeva, T. A., and Stuart A. Umpleby. "Adding a Dimension to the Philosophy of Science with an Illustration from Economics." Proceedings of Socio-Cybernetics Conference, June 29 to July 5, 2003, Corfu, Greece. 2003.

Medvedeva, T. A. "View of V.E. Lepskiy's and S.A. Umpleby's Theories of Cybernetics through the Prism of Intellectual Traditions." Edited by Vladimir Lepskiy. In *Reflexive Processes and Control*, 32-37. Proceedings of XI International Symposium "Reflective Processes and Control", October 16-17, 2017, Moscow, Russia. M.: Cognito – Center, 2017.

McCulloch, Warren S. *Embodiments of Mind*. Cambridge, MA: MIT Press, 1965.

Müller, Karl H. *The New Science of Cybernetics: The Evolution of Living Research Designs*. Vol. 2. Theory. Vienna: Ed. Echoraum, 2011: 277–316.

Pias, Claus. *Cybernetics: The Macy-Conferences 1946-1953*. Zürich: Diaphanes, 2003.

Popper, Karl R. *The Poverty of Historicism*. Boston: Beacon Press, 1957.

Popper, Karl R. "Three Worlds." Lecture, University of Michigan, April 7, 1978.

Riegler, A., and K. H. Mueller. "A Special Issue on Second Order Science." *Constructivist Foundations* 10, no. 1 (November 2014).

Rubinshteyn, Sergei L. *The Selected Philosophical-psychological Works*. Moscow: Nauka, 1997. (in Russian).

Schwaninger, Markus. *Intelligent Organizations Powerful Models for Systemic Management*. 2nd ed. Berlin, Heidelberg: Springer Berlin Heidelberg, 2008.

Shchedrovitsky, G. P. "Reflexion and Relevant Problems." *Reflexive Processes and Control* 1, No. 1, 41-45.

Smith, V. L. *Bargaining and Market Behavior: Essay in Experimental Economics*. Cambridge, UK: Cambridge University Press, 2000.

Soros, George. *The Alchemy of Finance: Reading the Mind of the Market*. New York: Simon and Schuster, 1987.

Stepin, V. S. *Theoretical Knowledge*. Verlag: Springer, 2005.

Sun-tzu. *The Art of War*. Translated by Denma Translation Group. Boston, MA: Shambhala, Random House, 2001.

Umpleby, Stuart A. "On Making a Scientific Revolution." In H. von Foerster (ed.) Biological Computer Laboratory, University of Illinois, Urbana, IL, 1974.

Umpleby, Stuart A. "Second Order Science: Logic, Strategies, Methods." *Constructivist Foundations* 10, no. 1 (2014): 16-23. http://www.univie.ac.at/constructivism/journal/10/1/016.umpleby.pdf.

Umpleby, Stuart A. "Second Order Cybernetics as a Fundamental Revolution in Science." *Constructivist Foundations* 11, no. 3 (2016): 455-81. http://www.univie.ac.at/constructivism/journal/articles/11/3/455.umpleby.pdf.

Umpleby, Stuart A. "Creating a Science of Purposeful Systems." Proceedings of a Conference of the World Organization for Systems and Cybernetics, January 2017, Rome, Italy. 2017.

Vernadsky, V. I. *Geochemistry and the Biosphere*. First English Translation from the 1967 Russian Edition of Selected Works, Santa Fe, NM: Synergetic Press, 2007.

Vygotsky, L. "The Genesis of Higher Mental Functions." In *The Concept of Activity in Soviet Psychology*, edited by J. Wertsch, 144-81. Armonk, NY: Sharpe, 1981.

Watzlawick, Paul, Janet Helmick Beavin and Don D. Jackson. Pr*agmatics of Human Communication; A Study of Interactional Patterns, Pathologies, and Paradoxes.* New York: Norton, 1967.

Watzlawick, Paul. *How Real Is Real?: Confusion - Disinformation - Communication*. London: Souvenir Press, 1983.

Watzlawick, Paul, John H. Weakland, and Richard Fisch. *Change: Principles of Problem Formation and Problem Resolution*. New York: W.W. Norton, 2011.

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