EXPANDING SCIENCE AND ADVANCING DEMOCRACY: TWO CURRENT PROJECTS IN CYBERNETICS

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Abstract

Systems Science, cybernetics and complexity are closely related fields. To illustrate, this article describes two projects in contemporary cybernetics that may be of interest to those concerned with complexity and policy studies. The first project is an effort 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 project is an effort to develop reflexivity theory into a general theory of purposeful, self-directed systems, thus improving our understanding and management of social systems. The article ends with some comparisons of complexity and cybernetics.

Keywords: second order cybernetics, correspondence principle, constructivism, pragmatism, epistemology, third order cybernetics, reflexivity, 30 years war, complexity

Introduction for the Conference on Complexity and Policy Studies

Let me begin by explaining my purpose in attending this conference. I am presently serving as president of the Executive Committee of the International Academy for Systems and Cybernetic Sciences (www.iascys.org). It is an honor society created a few years ago by the International Federation for Systems Research (www.ifsr.org). Other federations of systems societies that now work with IASCYS are the World Organization for Systems and Cybernetics (wosc.co) and the European Union for Systemics (www.ues-eus.eu/en/). The purpose of the Academy is to recognize people who have made outstanding contributions to the fields of systems science and cybernetics and to elect them as academicians. We would also like to include in the Academy people from the field of complexity.

Although primarily an honor society the Academy has also proven to be effective in increasing communication among scholars in different countries and among academic societies in the same country. I believe that systems science, cybernetics and complexity are neighboring fields with somewhat different interests and histories. The fact that there are three different fields is shown by the fact that the previous societies, journals, and conferences have continued and new ones have been founded. So, how is complexity different from cybernetics? I shall describe two subjects of investigation in cybernetics that have policy implications. I think these two subjects will be of interest to people at this conference on Complexity and Policy Studies. Using these two examples, I shall then suggest how contemporary cybernetics is similar to and different from complexity research.

The first example will be work on expanding the conception of science in accord with the Correspondence Principle. This work has been done primarily by scholars in the US and Europe. The second example will be work that Russian scholars are doing on extending cybernetics into the realm of large social systems by creating a philosophy and theory of self-regulating societies. This example describes work now being done by scholars in Russia, which has attracted attention from scholars in N. America, Europe and China.

First Project: 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 talk about 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. He asked, "How does the brain work?" McCulloch (1965), Maturana (1975), von Foerster (2003) and others conducted biological experiments. They concluded 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 (von 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 US 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 do we 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 was persuaded to adopt the new point of view. But could there be a more definitive sign? Perhaps the Correspondence Principle would help.

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

Table 1. Definitions of First- and Second-Order Cybernetics

The Correspondence Principle was proposed by Bohr (1920) 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? (Figure 1).

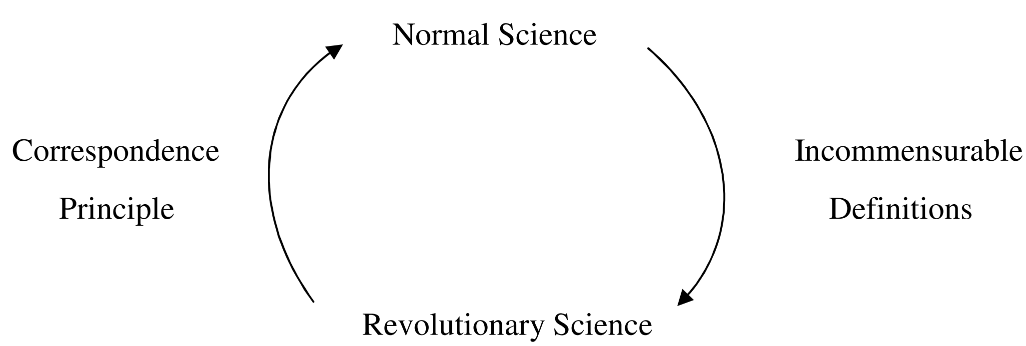

Figure 1. How Science Advances

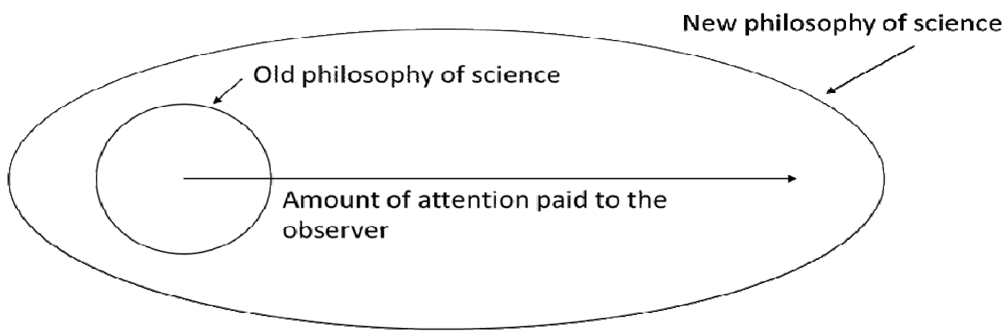

Figure 2. Expanding Science in Accord with the Correspondence Principle

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, 2005). 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 realist 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 realism 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).

	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 versus Scientific Theories	Realism versus Constructivism	The biology of cognition versus 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

Table 2. Three Versions of Cybernetics

Second Order Cybernetics

In recent years there has been a transition from speaking about second order cybernetics to describing also second order science (Kauffman, 2016); Müller, 2011; Riegler & Mueller, 2014). 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.

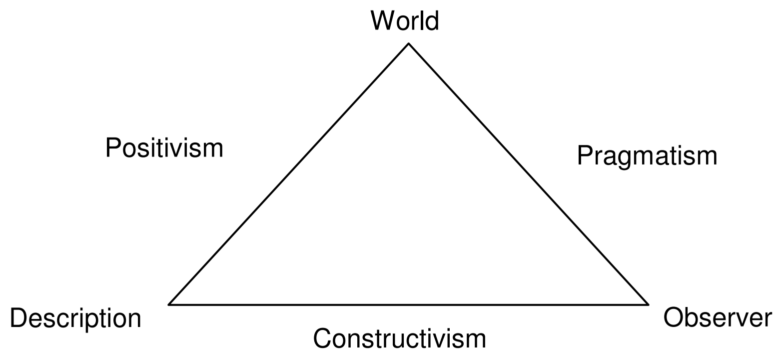

Figure 3. Three Epistemologies

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 (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. This is needed to explain not just how to conduct an experiment but also what the background of the scientist is—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 what actions would 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. 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 on several campuses. 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 science by clarifying how the natural sciences and the social sciences are similar and different.

There are additional practical implications. Expanding the philosophy of science will help American scientists understand and cooperate with more philosophically oriented European scientists. The larger conception of science will contribute to quality improvement methods in science by developing methods of meta research. The new conception of social science will shift the focus of attention in social science research from studying interactions among variables to paying more attention to goals, purposes and ideas which are fundamental to social systems.

Second Project: Creating a Reflexive Philosophy of Government

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." 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.

At a meeting of Lepskiy's group in Moscow in October 2017, I described the recent work on second order cybernetics in the US and Europe and offered some thoughts on 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 (Lefebvre, 1982; Lepskiy, 2017).

An important concept in third order cybernetics in Russia is the idea of a meta subject—the environment or context of a subject of investigation. 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, a region, or the world.

At the micro level the fields of psychology, therapy, and sociology have been influenced by cybernetics. Key authors are Bateson (1972), Donald Jackson, Watzlawick (1974, 1983) and 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, Beer (1972), Ackoff (1981), Checkland (1999), and Schwaninger (2008).

At the macro level to find the key authors one must go farther back in time. In the seventeenth century, people in Europe were trying to create self-governing societies. The task was to build a reflexive society, one in which people 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 30 years' war (1618–1648) about 1/3 of the people in Europe were killed in wars between Protestants and Catholics.

During the 30 years' war many people moved from Europe to N. America to escape the religious conflicts. The Peace of Westphalia, that ended the war, supported the idea of religious freedom and largely created the conception of a 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 N. 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 were independent and each could check the power of the others. Other institutions were 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 to provide personal security, trial by jury, the right 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 Popper (1957) called "piecemeal social engineering" and what 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 interpretation of third order cybernetics offers a non-ideological way of comparing and improving social systems. It opens the door to conversations about the historical reasons for the development of particular institutions in the West and the East. This is an important addition to cybernetics and to policy discussions.

Complexity and Cybernetics

The fields of complexity and cybernetics are similar in that they are located outside the traditional disciplines. Their concerns are transdisciplinary. Cybernetics started in the late 1940s; complexity in the 1980s. In the 1960s cyberneticians held a series of meetings on self-organizing systems (Ashby, 1962; von Foerster, 1960). This work has been continued in the field of complexity, aided by advances in computers. Early interest in cybernetics came from engineering, particularly automatic control processes. Later work emphasized the man-machine interface, management and the biology of cognition. More recently work in cybernetics has been concerned with design and with the philosophy of science. Meanwhile the work in complexity has greatly extended the earlier work on self-organizing systems. Agent based models are a new type of computer simulation. More interaction in the future among the various transdisciplinary fields will benefit everyone. See Table 3 for a preliminary comparison of cybernetics and complexity science.

	Cybernetics	**Complexity**
Origin of the field	Macy Conferences, 1946–1953	1980s, Santa-Fe Institute
Definition of field	Control and communication in animal, machine and social systems; a science of purposeful systems	New entities and patterns of behavior emerge when many agents interact and adapt to one another and their environments
Key authors	W. McCulloch, N. Wiener, H. von Foerster, M. Mead, G. Bateson, H. Maturana	M. Gell-Mann, G. West, R. Axtell, B. Arthur, J. Holland, S. Kauffman, S. Wolfram
Purpose	Create a science of perception, regulation, learning, adaptation, purposeful behavior and understanding	Identify the unseen mechanisms and processes that shape evolving worlds
Methods	Methods from any discipline	Rigorous logical, mathematical, computational methods
A key question	How does the brain understand itself? How can we create a reflexive science? How can we create self-governing societies?	How do order and novelty emerge in the world?
How science advances	Add a new dimension	Find common patterns
Internal mechanisms	Reflexivity operates on two levels—observing and participating	Complexity involves two processes: creating new variety and selecting appropriate variety
Locus of contribution	Extensions of philosophy	Extensions of mathematics

Table 3. A Comparison of Cybernetics and Complexity

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