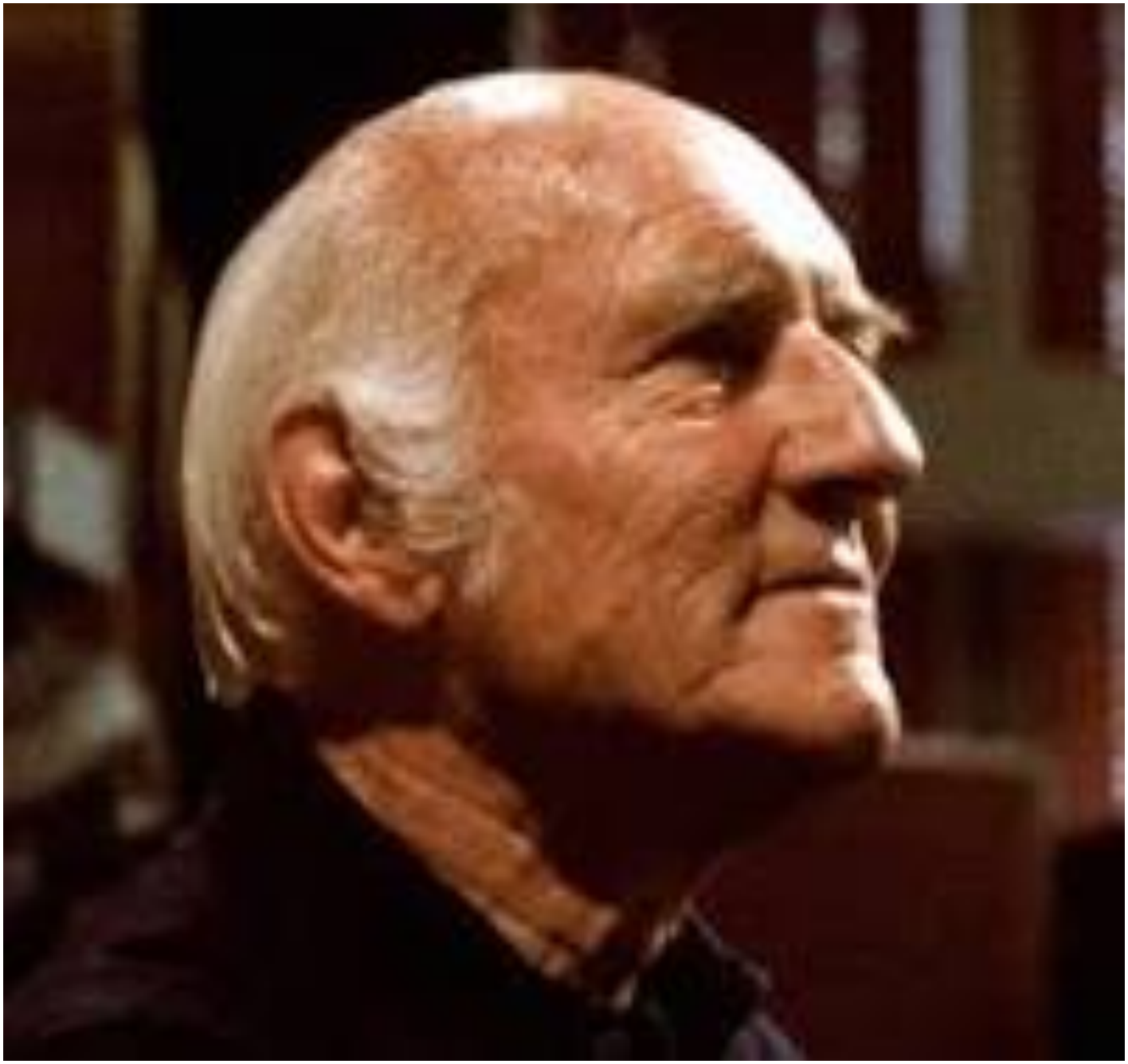
Second Order Cybernetics Then and Now

Stuart A. Umpleby
The George Washington University
Washington, DC
www.gwu.edu/~umpleby

Heinz von Foerster



Von Foerster is well-known for many contributions

- The mechanism of memory
- An equation describing population growth
- A thought experiment illustrating self-organization
- Neurophysiological evidence illustrating the individual construction of a reality
- A radical view of ethics

Possibly a larger contribution

- Heinz von Foerster showed us how to expand the scientific enterprise when circumstances require, not just contribute to a specific field
- Second order cybernetics provides an example of how to expand science
- It provides an example of a scientific revolution within the philosophy of science

Heinz's goal

- Heinz's goal was to include the observer in the domain of science
- When I speak to physicists about second order cybernetics and including the observer, they often think of the Heisenberg Uncertainty Principle
- But events at the atomic level are quite different from the biology of cognition

Warren McCulloch

- Heinz was greatly influenced by Warren McCulloch
- Both McCulloch and von Foerster wanted to understand cognition
- McCulloch invented the term, “experimental epistemology”-- testing epistemological theories through neurophysiological research

Warren McCulloch

Origins of cybernetics

- Following World War II there was excitement about the utility of applied science
- The Josiah Macy, Jr. Foundation conferences in New York City 1946-1953 were chaired by Warren McCulloch
- “Circular Causal and Feedback Mechanisms in Biological and Social Systems”

Gregory Bateson

Margaret Mead

Norbert Wiener

Arthuro Rosenblueth

W. Ross Ashby

How I met Heinz

- I came to know Heinz by hearing him speak on campus
- At a luncheon he forecasted that in the future human beings would make three discoveries
  - The earth is finite – human population cannot grow indefinitely
  - Power resides where information resides
  - A is better off when B is better off

My interest in BCL

- I began to visit the Biological Computer Laboratory
- When I had a question, Heinz would answer and then talk about his own work
- Frankly I thought Heinz was a bit odd
- He was more cheerful, more enthusiastic, and more energetic than anyone I had met
- Also, he wanted to include the observer in science

An early misconception

- I thought that Heinz's message was similar to that of Thomas Kuhn in the book, *The Structure of Scientific Revolutions*
- For example, consider this quote: "The proponents of competing paradigms practice their trades in different worlds. One contains constrained bodies that fall slowly, the other pendulums that repeat their motions again and again…

Practicing in different worlds, the two groups of scientists see different things when they look from the same point in the same direction. Again, that is not to say that they can see anything they please. Both are looking at the world, and what they look at has not changed. But in some areas they see different things, and they see them in different relations one to the other.

That is why a law that cannot even be demonstrated to one group of scientists may occasionally seem intuitively obvious to another. Equally, it is why, before they can hope to communicate fully, one group or the other must experience the conversion that we have been calling a paradigm shift…”

Sociology vs. neurophysiology

- Heinz said he was not saying the same thing as Thomas Kuhn
- Soon thereafter he gave a lecture in the Dept. of Electrical Engineering and published “On Constructing a Reality,” which described several neurophysiological experiments
- With that article I made the paradigm shift
- I thought what Heinz was saying was fascinating, important and an opportunity

How the nervous system works

- The blind spot
- Image on your retina
- Move your eyes within your head
- Conversations at a party
- Listening to a speech
- Two kittens
- Injured war veterans

The meaning of these experiments

- The brain does a great deal of work for us that we are not aware of
- What we think we see or hear is not always there
- Our senses are fallible
- Observations independent of the characteristics of the observer are not physically possible

Cybernetics in 1975

- McCulloch on experimental epistemology
- Bateson on the double bind
- Wiener's concept of a second industrial revolution
- Rapid growth of computers and robotics
- Some work by artists and composers (Brun)
- Maturana's concept of autopoiesis
- Work on second order cybernetics was beginning

A distributed network

- In the late 1970s the members of BCL communicated via EIES at NJIT under an NSF grant
- The American Society for Cybernetics was revived
- Tutorials on second order cybernetics were held prior to many conferences

Advocating the new view

- Pask, Glanville, me and others organized symposia and presented tutorials in Vienna, Amsterdam, and at ASC conferences
- von Foerster, von Glasersfeld, Maturana and Varela were leading speakers
- Mostly we sought to distinguish first order cybernetics and second order cybernetics

Gordon Pask

Ranulph Glanville

Ernst von Glasersfeld

Humberto Maturana

Francisco Varela

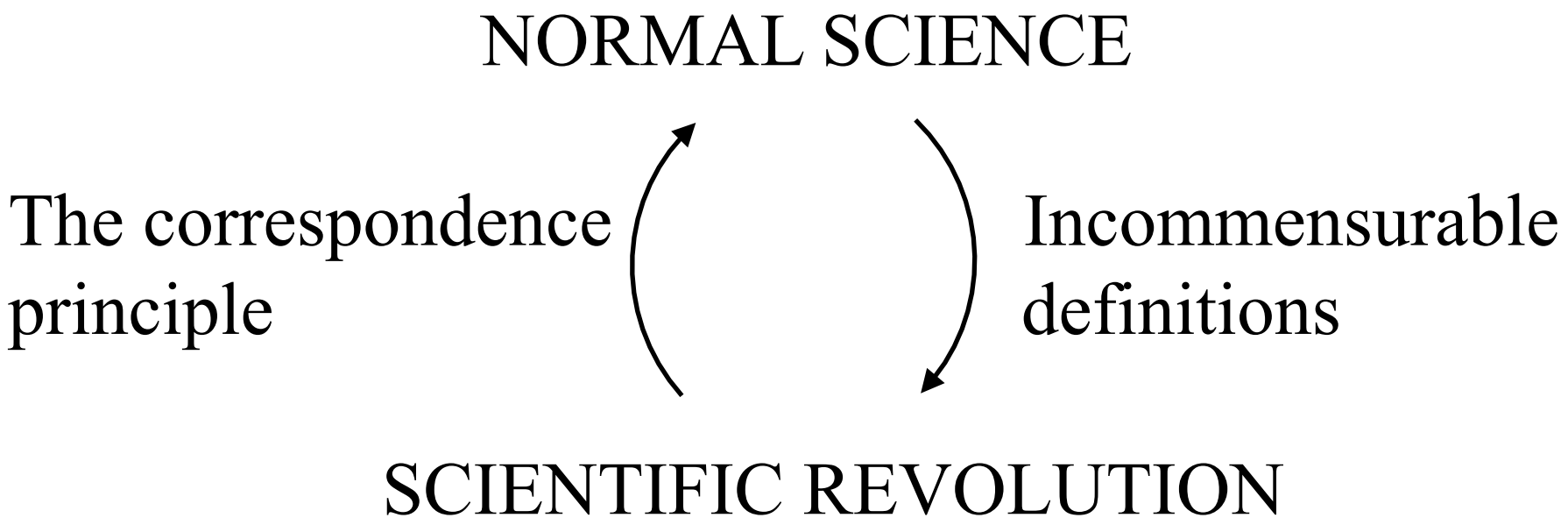
Author	First Order Cybernetics	Second Order Cybernetics
Von Foerster	The cybernetics of observed systems	The cybernetics of observing systems
Pask	The purpose of a model	The purpose of a modeler
Varela	Controlled systems	Autonomous systems
Umpleby	Interaction among the variables in a system	Interaction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

Definitions of First and Second Order Cybernetics

The next step of the revolution

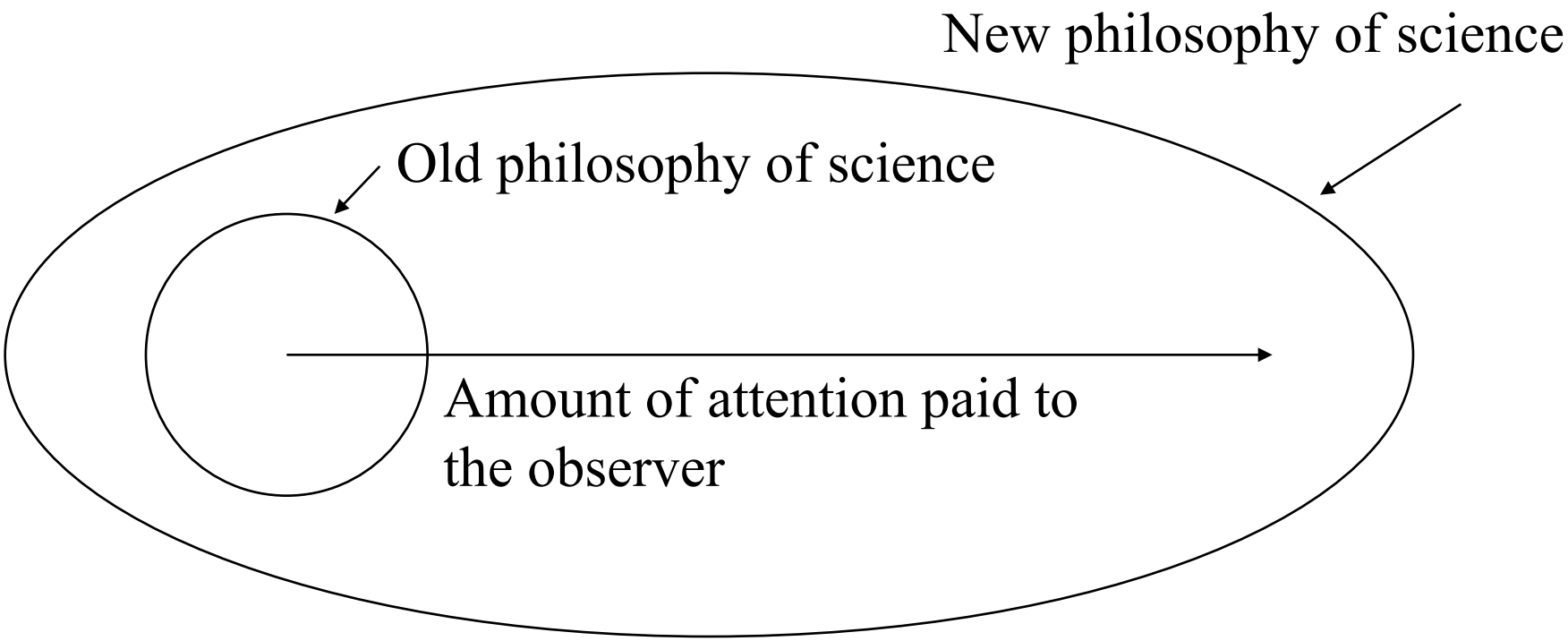
- We needed to go beyond repeatedly defining differences between first and second order cybernetics
- I thought the Correspondence Principle might help
- Kuhn and Popper both mentioned the CP but did not use it much
- Von Foerster told me about the CP but did not use it himself

The cybernetics of science



The Correspondence Principle

- Proposed by Niels Bohr when developing the quantum theory
- 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
- A new dimension is required



An Application of the Correspondence Principle

How cybernetics is different

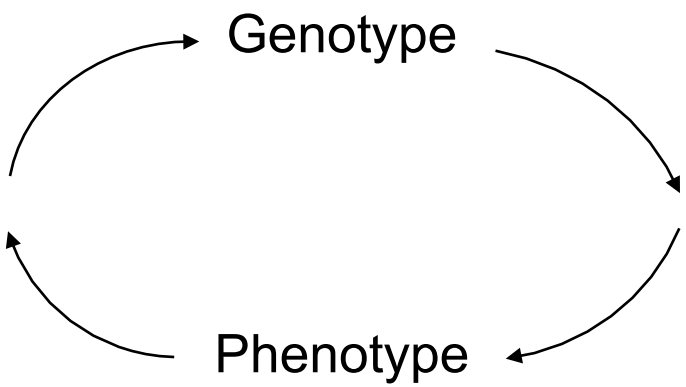
- Most fields of science look for relationships among variables in some observed system
- Cybernetics has basically two elements – the regulator and the system being regulated
- There is a circular causal relationship between the two
- This is a very general conceptualization that can be used for biological and social systems

Examples of regulation

- The iris controls light reaching the retina, hunger and eating, thirst and drinking
- A person driving a car, an executive managing a firm, a govt agency regulating an industry, the voters of a country choosing representatives
- Common functions of living systems are perception, selection, learning, adaptation

How would social science change?

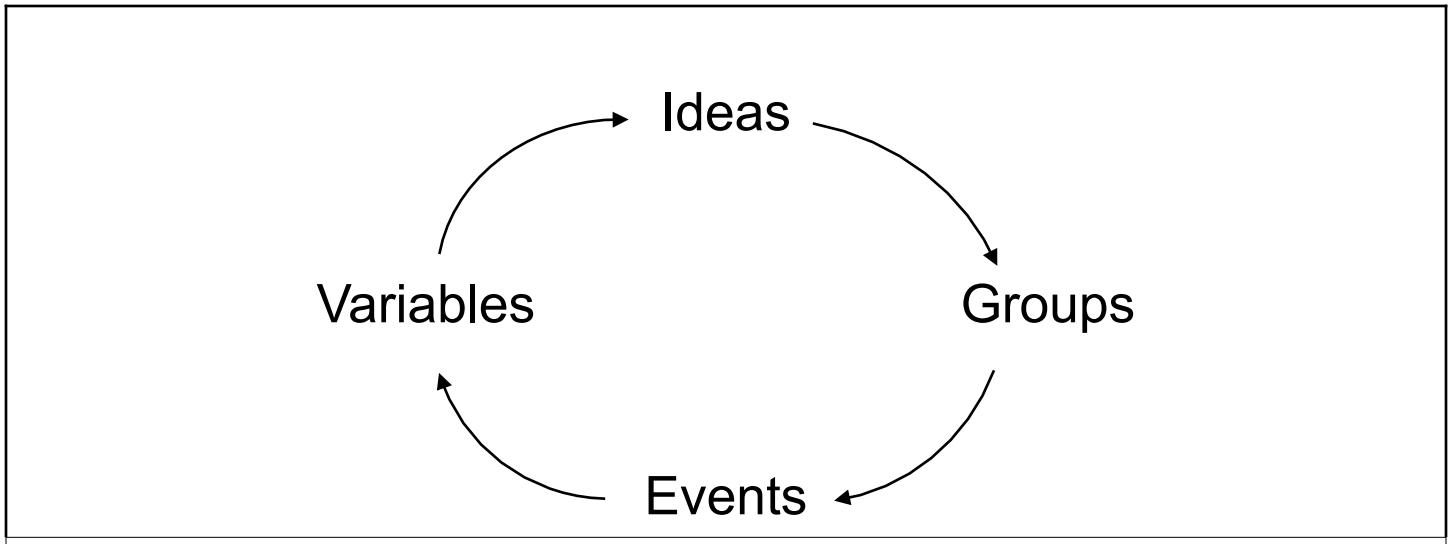
- Use several disciplines when describing a social situation – ideas, groups, events, variables
- Describe the interaction between ideas and society – the consequences of previous theories



Karl Mueller's epigenetic theory

Ways that disciplines describe social systems

- Variables – physics, economics
- Events – computer science, history
- Groups – sociology, political science
- Ideas – psychology, philosophy, cultural anthropology
- Interaction between ideas and events, a "shoelace model"



A model of social change using four methods for describing systems

How social systems change

- Study a social system (variables) and generate a reform proposal (idea)
- Persuade and organize people to support the idea (groups)
- Produce some change, for example start a business or pass a law (event)
- Study the effects of the legislation on the social system (variables)

Advantages of using all four methods

- A richer description of the social system is produced
- Important considerations are less likely to be overlooked
- The theories and methods of more than one discipline are used

The Interaction Between Ideas and Society

Ideas	Events
	1096 First Crusade
Interest in trade and in ancient learning	
	Marco Polo's trip to China
Science and technology stimulated by desire to improve trade	
	Traders accumulate wealth, nation–states develop and protect trade routes
The idea of progress, people strive to produce more than mere subsistence	
	Industrial Revolution in England
Adam Smith's *The Wealth of Nations*, 1776	
	Capital accumulation, urbanization, growing gap between rich and poor
Marx and Engles, *The Communist Manifesto*, 1848	
	Revolutions in Europe, demands for more equal distribution of wealth
Social reform movements in industrializing countries	
	World War I and the Great Depression
Keynes's theory justifying government intervention in the economy	
	World War II, World Bank and IMF established, decolonialization of the Third World
Friedman's monetary policy	
	Oil crisis in 1973 leads to abandonment of gold standard and fluctuating exchange rates
Environmental movement and futures research movement, many conferences on the "world problematique"	
	Economic progress in Asia, liberalization of communist regimes

Cybernetics and social systems

- Cybernetics looks at the interaction between ideas and society
- And treats scientific ideas as influencing the behavior of social systems
- In this way cybernetics provides a way of studying the impact of science on society
- Studies of science and society have been more empirical than theoretical

Should we revive or replace the philosophy of science?

- The philosophy of science has become rather inactive in recent years
- Karl Mueller has suggested that its role of critiquing and guiding science has to some extent been taken over by cybernetics
- But should cybernetics revive or replace the philosophy of science?
- New trends: big science, big data, internet

Advantages of reviving the philosophy of science

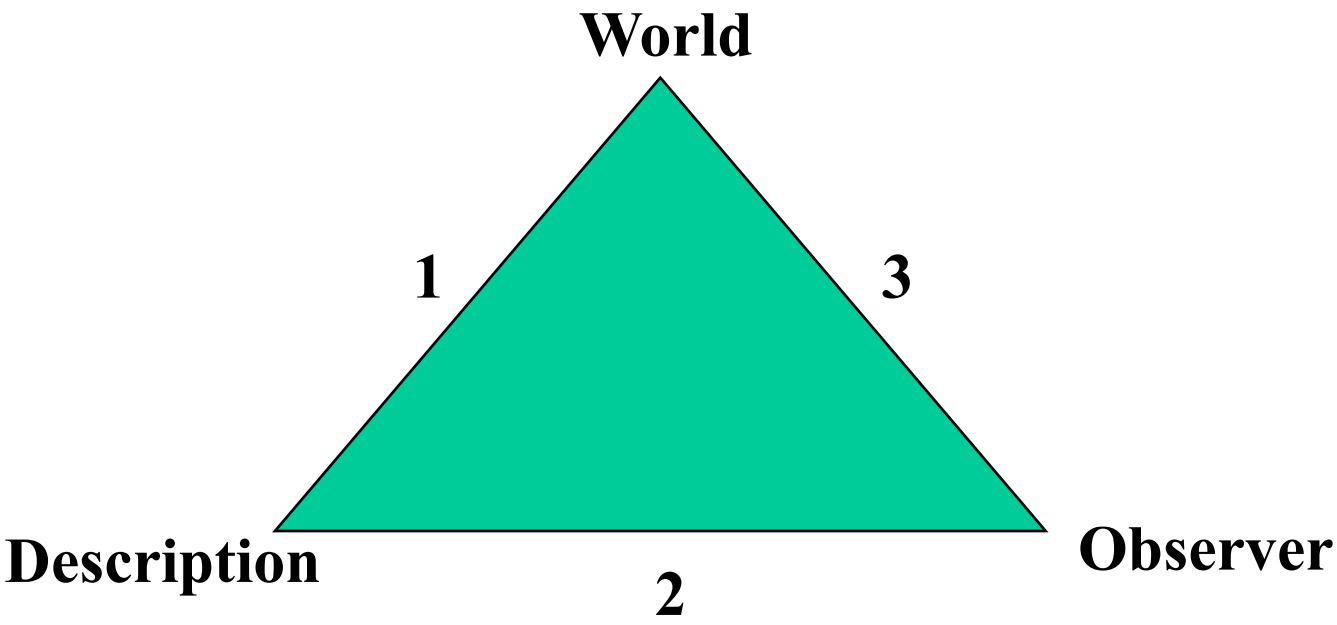
- Departments of philosophy already exist on university campuses
- Courses in the philosophy of science are taught on most campuses
- Second order cybernetics is not taught on any U.S. campus
- Philosophy journals might provide a way of reaching interested people

How cybernetics provides a theory of philosophy

- At a dinner in Vienna in November 2005 Karl Mueller mentioned Heinz von Foerster's 1971 article "Computing in the Semantic Domain
- Von Foerster described a triangle and labeled two sides syntactics and semantics
- Mueller wondered what the third side would be

Creating a theory of epistemologies

- I suggested “pragmatics”
- Later in thinking about the triangle it occurred to me that the three sides corresponded to three points of view in the history of cybernetics – engineering, biological, and social cybernetics
- The triangle suggested a way to unify previously competing epistemologies


World
1
3
Description
2
Observer

Epistemological triangle

World and description	Observer and description	Observer and world
Syntactics	Semantics	Pragmatics
Representation concept of truth	Coherence concept of truth	Pragmatic concept of truth
British Empiricism	German Idealism	American Pragmatism
Inanimate Objects	Knowing Subjects	Social Reforms
Unquestioned Objectivity	Constructed Objectivity	Contested Objectivity
Form	Meaning	What works

How cybernetics expands science

- The classical approach to science would be the left side of the triangle
- Second order cybernetics would be the whole triangle including the scientist reflecting on his or her descriptions and seeking to act in the world
- The triangle suggests that second order cybernetics is no longer a competing epistemology but a theory of epistemologies

The present and future of cybernetics

- The computer-oriented disciplines in cybernetics have NOT been influenced by second order cybernetics
- The more humanistic disciplines of cybernetics HAVE been influenced by second order cybernetics

The computer-oriented disciplines in cybernetics

- Computer science
- Artificial intelligence and robotics
- System dynamics modeling
- Complex adaptive systems (an alternative approach to simulation)
- Most recently, data analytics or “big data”

The more humanistic disciplines of cybernetics 1

- HVF in *The Beginning of Heaven*… rethought the physical sciences using a constructivist epistemology
- Karl Mueller's interpretation of levels of science and how to do research on multi-level, self-referential systems
- Mueller's conception of meta research, the integration of previous studies, and the design of a new kind of doctoral program

The more humanistic disciplines of cybernetics 2

- Cybernetics in management
- The influence of cybernetics in design and architecture
- Family therapy and psychotherapy
- Science fiction and literary analysis
- Cognitive studies and consciousness
- The influence of Niklas Luhman on sociology and legal studies in Europe

The more humanistic disciplines of cybernetics 3

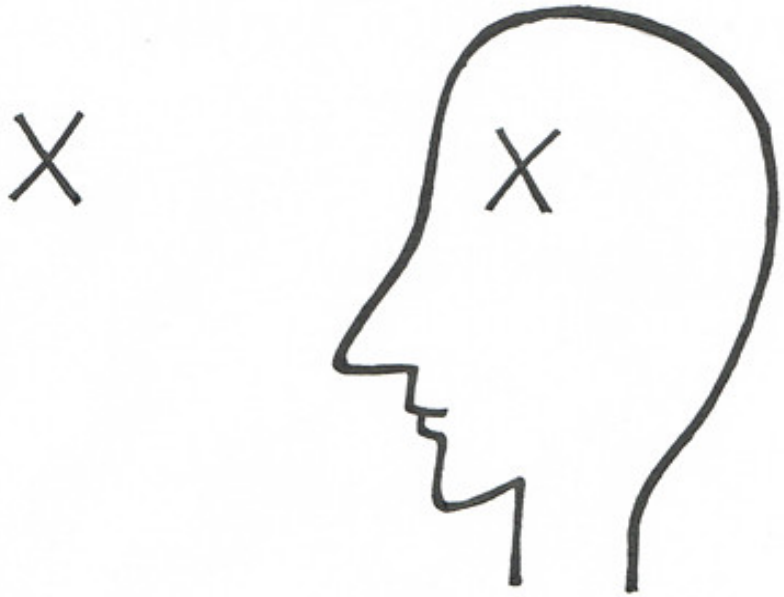
- George Soros's advocacy of reflexivity theory as an alternative to equilibrium theory in economics
- A more multi-disciplinary, applied approach to the conduct of social research
- Adding two dimensions to the philosophy of science

Adding a second dimension to the philosophy of science

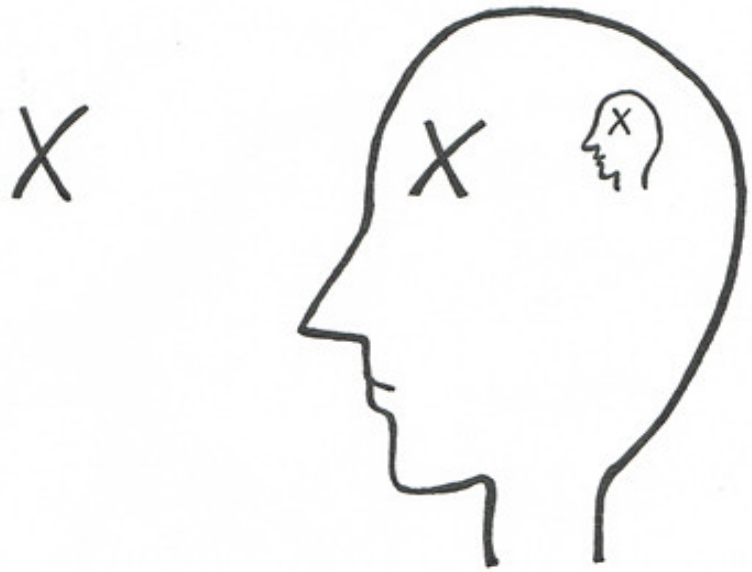
- Theories, when accepted and acted upon, affect the behavior of social systems
- A second dimension would be the amount of effect a theory has on a social system
- This second dimension can be added to the philosophy of science in accord with the correspondence principle

Three ways to think about the role of science

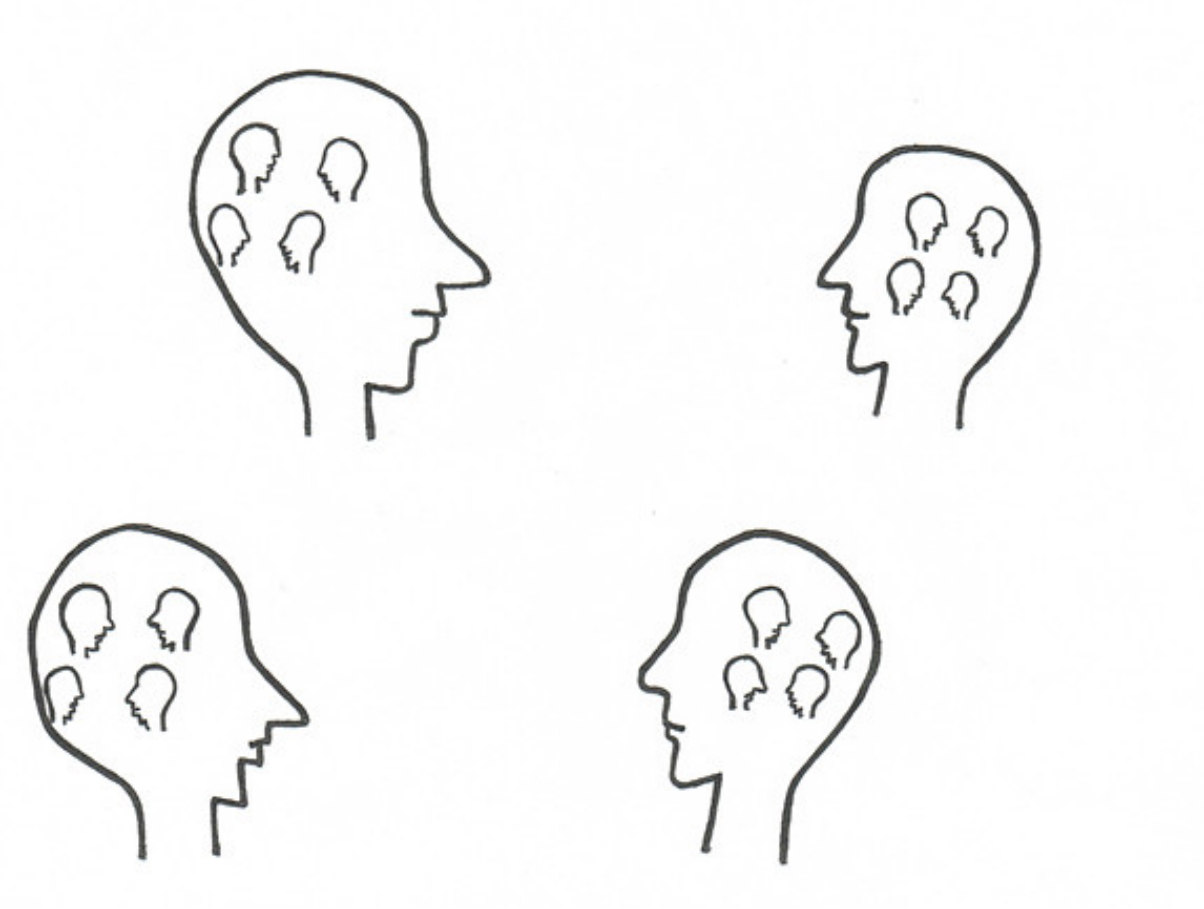
The task of science is to produce accurate descriptions



The observer should be included within the domain of science



Social systems consist of observers who also participate



The use of knowledge in regulating social systems

- By providing a general theory of regulation cybernetics provides a theory of how knowledge is used in social systems
- Hence, cybernetics provides what the philosophy of science intended to provide – guidelines for creating scientific knowledge
- Cybernetics also provides a theory for science and society studies

A cybernetics view of economics

- Academic articles by economists focus on linear causal relationships, for example factors contributing to a financial crisis or consequences of a financial crisis
- Articles by journalists often describe boom and bust cycles which can be depicted using positive and negative feedback loops
- A cybernetics critique of economics would suggest more attention to circular causality

The contributions of cybernetics

- Developed a theory of circular or regulatory phenomena including goal seeking and goal formulation
- Created a theory of perception, learning, cognition, adaptation, meaning, understanding
- Includes the observer within the domain of science
- Created a theory of the use of knowledge in society, reflexivity

Then and now

- Second order cybernetics is an effort to tell people that there is more to cybernetics than they think
- There is also more to science
- Using the Correspondence Principle may be a way of making this point
- All previous research is included in the new point of view and supports the new view

Heinz's contribution

- Heinz von Foerster challenged a key assumption underlying the philosophy of science
- He showed that scientific fields can contribute to revising or expanding the philosophy of science
- He initiated a scientific revolution within the philosophy of science

Contact information

Stuart A. Umpleby
Department of Management
The George Washington University
Washington, DC

www.gwu.edu/~umpleby
umpleby@gmail.com

A lecture prepared for the

Heinz von Foerster Society

Vienna, Austria

November 18, 2013