A Second Expansion of Science

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Science is changing

- How are we to understand the changes now occurring?
- What will the changes mean for academic fields?
- Will there be changes in the structure of universities?

Physics and cybernetics

- Physics provides a general theory of matter and energy which is used in the engineering disciplines
- Cybernetics provides a general theory of control and communication, of information and regulation, which underlies the social sciences and design
- Presently the social sciences have no common foundation other than cybernetics

Learning from physics

- Can we learn from physics how to create a common foundation for the social sciences?
- I think so, but the approach that is needed is different from the approach that has been used up to now
- The focus should not be on systems themselves, but rather on the regulation of systems (more on this later)

Current thinking about imitating physics

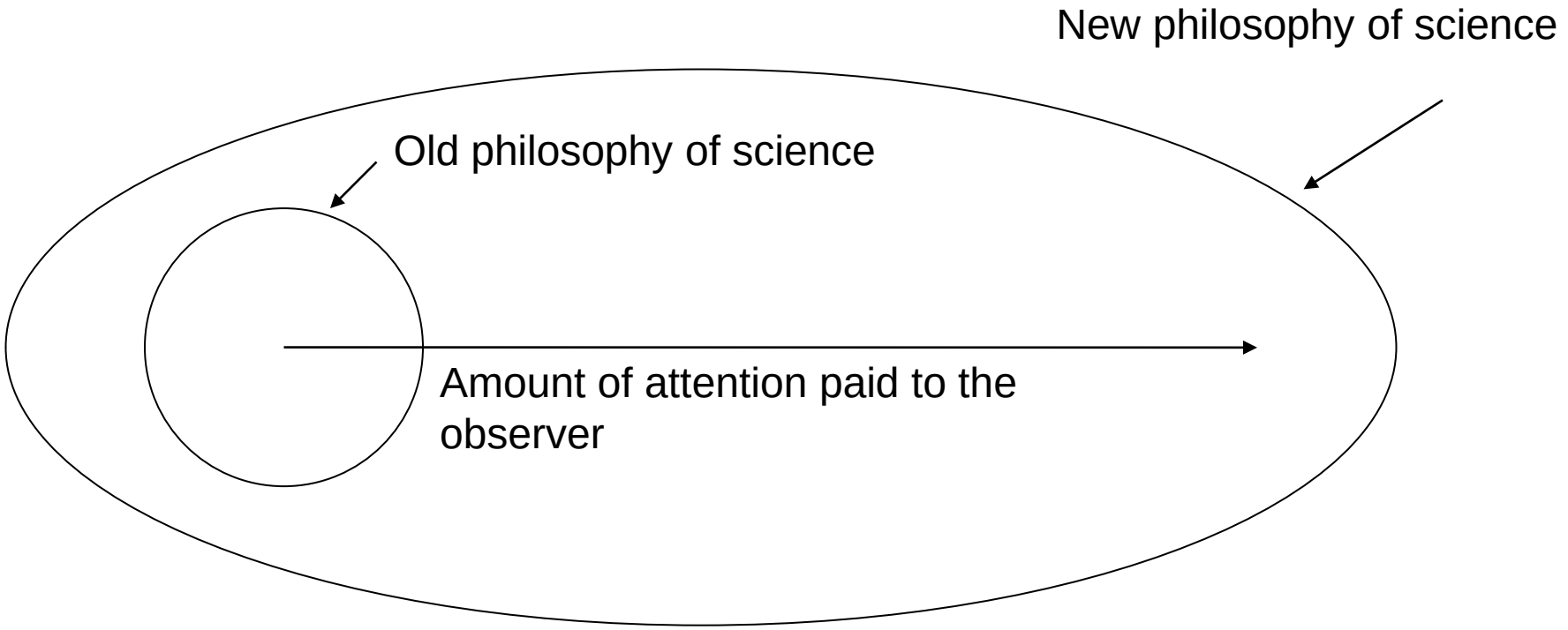
- Use Popper's idea of conjectures and refutations – create a hypothesis, ideally a mathematical model and test it with empirical data
- Quantitative predictions are better than merely qualitative predictions

An alternative way of imitating physics

- Use the Correspondence Principle to make incremental advances
- Recognize that not all social science disciplines have ready access to quantitative measurements. Economics does, but psychology, anthropology, sociology, history and political science are less easily quantified

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
- The Correspondence Principles describes how science advances



An Application of the Correspondence Principle

Advantages of the Correspondence Principle

- All the data that supported the old theory also support the new theory
- Phenomena that were previously neglected can now be explained

Two sets of additions to science

- In the years after World War II several approaches to systems science were created. These fields were different from the traditional disciplines, and they created the systems sciences
- In recent years two philosophical ideas have been widely accepted. They constitute a second expansion of science

Key fields in systems science

- General systems – U of Michigan, MHRI
- Cybernetics – UIUC, BCL
- System dynamics – MIT
- Systems approach – U of Penn
- Quality improvement – consultants
- Learning organization – Harvard, MIT

Characteristics of these fields

- Each group had its own meetings, its own journals, and its own founders/ leaders
- Each field was addressing certain questions and invented concepts and methods to deal with those questions
- Not all fields used the same distinctions or emphasized the same concerns

Dimensions identified by Eric Dent (most used)

1. From entities to relationships 6
2. From reductionism to holism 6
3. From linear to circular causality 6
4. From environment free to environment full investigations 5
5. From not knowing subjects to knowing subjects 5

Dimensions identified by Eric Dent (least used)

6. From determinism to indeterminism 3
7. From direction to self-organization 2
8. From not including the observer to including the observer 2

Six systems fields (number of dimensions used)

- Total quality management 4
- Operations research 5
- System dynamics 5
- Organizational learning 6
- General systems theory 6
- Cybernetics 8

The eight dimensions

- Pointed out by Eric Dent, define the systems sciences relative to earlier disciplines
- They explain why systems science had difficulty coming together as a unified field
- All the dimensions have now been widely accepted in the scientific community
- Including the observer was the last to be accepted

Two kinds of dimensions can be added to science

- Dimensions related to a specific field
  - The speed of light in physics
  - The effects of the family in psychotherapy
  - Assumptions about human behavior in economics
- Dimensions related to the philosophy of science
  -- A change in the philosophy of science can affect more than one discipline, potentially all disciplines

Two additional dimensions

- In recent years two additional dimensions have been increasingly discussed in cybernetics and systems science
- Including the observer in what is observed (This is the result of studies in the neurophysiology of cognition)
- Considering the effects of theories on social systems (influenced by reflexivity theory)

The biology of cognition

- Since the Macy Foundation conferences in the late 1940s and early 1950s cyberneticians have sought to understand cognition, primarily through philosophy, neurophysiology and mathematics
- By studying cognition they were studying the means whereby scientific knowledge is created
- They came to new conclusions about the philosophy of science

Conclusions from the biology of cognition

- All observations are produced by observers
- Observations independent of the characteristics of the observer are not physically possible
- Disciplinary background, as one example, affects what people pay attention to

Reflexivity in social systems

- In recent years George Soros's theory of reflexivity has received increased attention
- He notes that human beings in social systems both observe and participate
- By observing, thinking, and participating they change the way that social systems operate
- Hence, theories of social systems not only describe but also change social systems

The second expansion of science

- The interest in observers and reflexivity is creating another expansion of science which emphasizes that the social sciences are different from the physical sciences
- One result is a desire to create a “second order science” which describes the effects of first order theories (and second order theories) on phenomena of interest

The new point of view

- In addition to descriptions of the external world
- We include the observer and
- The effects of ideas on society
- We then have a larger conception of the practice of science which includes both the process of observation and the process of participation

A paradox in second order science

- People with practical concerns readily accept reflexivity
- The people who reject this view are scientists
- They are trying to do science using a point of view that works well for physical systems, but not for social systems
- It is fine to imitate physics, but one must understand how to do so

Our conception of science is the obstacle

- Including the observer in what is observed is not permitted by the classical conception of science
- The classical conception of science also assumes that theories do not affect what is described
- We can add these two considerations to the philosophy of science by using the Correspondence Principle
- In this way we create a single philosophy of science for both the physical and social sciences

Advantages in adopting the new view

- We shall pay attention to additional considerations (requisite variety)
- We shall not exclude factors that we know are important in our daily lives because they do not fit a particular conception of science
- We shall write not only literature reviews but also histories of the effects of previous theories

What will change

- In the social sciences, less focus on model building and data analysis as sources of knowledge
- More attention to participation, design, and holistic social experimentation
- Less emphasis on specialized knowledge
- More attention to the integration and use of knowledge

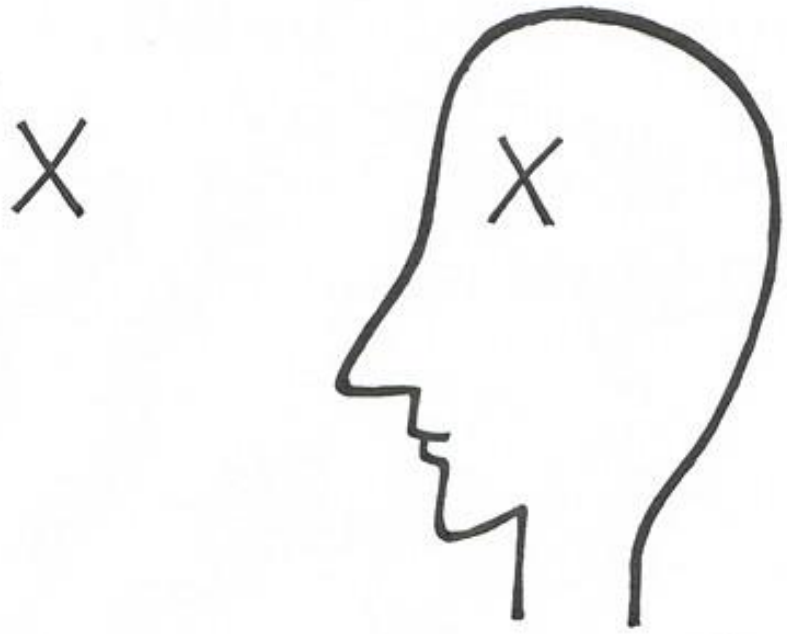
Two views of complexity

- If we view complexity as a characteristic of the observed system, then we have less control
- If we view complexity as lying in the relationship between observer and observed, we are encouraged to be more creative, to use multiple points of view
- The criterion of success shifts from comparing theory and data to successful, purposeful action

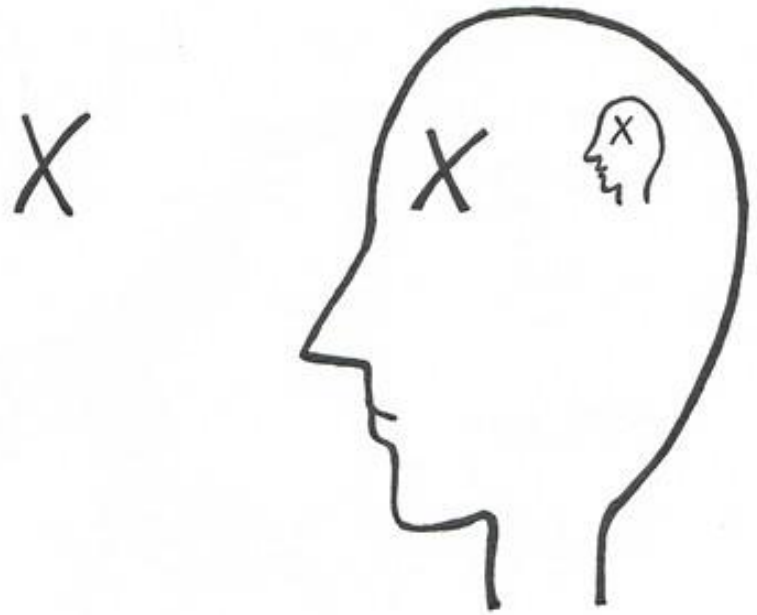
Three conceptions of cybernetics and of science

- Observations are formulated as variables describing some referent system
- One pays attention to observers as well as what they describe. Different observers often have different views
- Social systems are thought of not as collections of variables but rather as collections of observers who influence one another and act within the social system

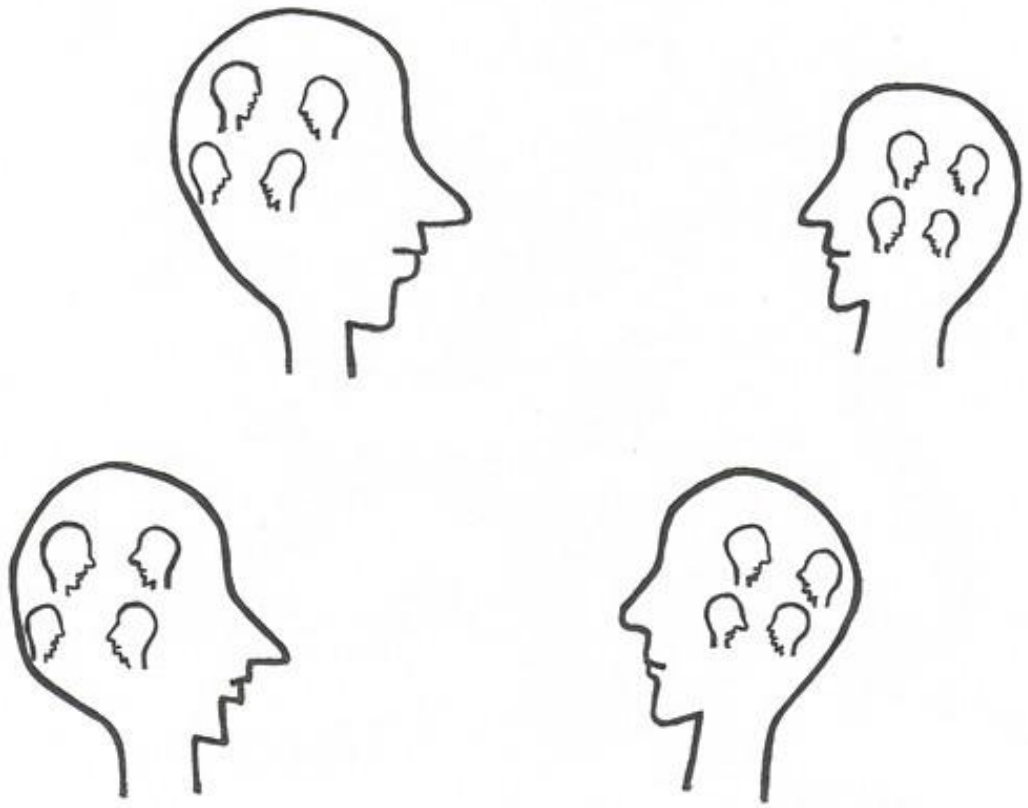
Describe some referent system



Pay attention to the observer and the observed



Think of a social system as a collection of observers



Current trends in universities

- No strong movement in U.S. toward the adoption and expansion of systems science
- In the 1980s and 1990s in the U.S. most systems science institutes were closed
- Now there is increased specialization due to the quest for higher ratings
- Publishing in journals “in your field” raises the rating of a university department or school

In business

- In most business schools students study accounting, marketing, finance and human resources management
- There may be a “capstone” course which is a business game
- At the University of St. Gallen in Switzerland there is a “St. Gallen Management Model” to which all the faculty contribute

In economics

- Presently in economics there are basically two points of view
  - Government regulation is sometimes needed
  - Government regulation should be minimized
- Which theory is actually used depends on decisions by political leaders
- There is no economic theory that describes which theory will be used. One must look to political science or to a general theory of control

An expected effect on university structure

- John Warfield proposed the “wandwaver solution” (available via a websearch)
- He observed that systems science institutes in universities did not last
- The destructive forces were
  - Academic specialization
  - Accrediting organizations
  - “Portfolio management” by new administrators

Warfield's proposed structure of a university

- A heritage college – what has been learned in the past; sciences, humanities, languages
- A professional college – business, law, medicine, engineering, agriculture
- A horizons college – design solutions to present and projected problems

Characteristics of the Horizons College

- Similar to an Institute for Advanced Study
- A focus on solving practical problems
- The curriculum would be systems and cybernetics
- The permanent faculty would major in systems and cybernetics
- Faculty members from the other two colleges would work on specific problems as needed

Purposes of the Horizons College

- Protect systems and cybernetics from accrediting organizations
- Increase problem-solving activities in universities
- Further develop systems and cybernetics through applied work
- Provide opportunities for interdisciplinary cooperation

In conclusion

- Science is expanding, but there is not yet a home for the new disciplines within contemporary universities
- Many disciplines have been affected and more disciplines will be affected
- The structure of universities may change
- Universities will probably become more active in solving large social problems

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