

# 09. Sociology of Science

## 1. Mertonian Sociology of Science (Robert Merton 1940's)

- Function of science is to produce knowledge.
- Accomplishes this by enforcing institutional *norms*.
- *Norms* = The rules that a group uses for appropriate and inappropriate values, beliefs, attitudes and behaviors.



Robert Merton  
(1910-2003)



*spittoon*

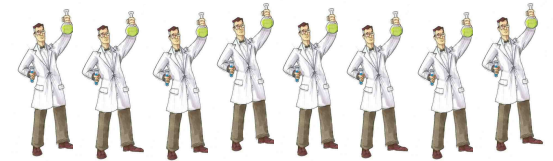
## A. Scientific Norms (what constrains scientists' actions)

- *Universalism* = The criteria used to evaluate a scientific claim should not depend on the identity of the person making the claim. (Impersonality of laws of nature.)



**Hoorah!**

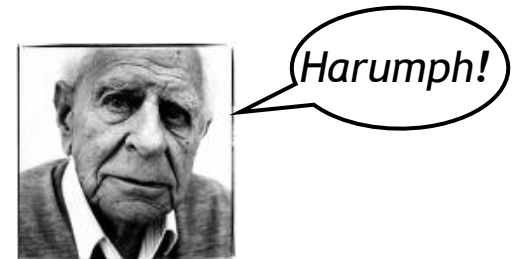
- *Communism* = Scientific knowledge should be communally owned.



- *Disinterestedness* = Scientists should disengage their interests from their actions and judgments.

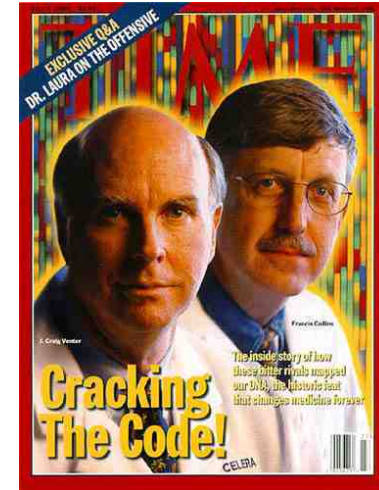


- *Organized Skepticism* = Scientific ideas should be subject to community-wide tests and challenges.



## B. Reward System (what motivates scientists to act)

- Reward in science = *recognition*.
- Encourages original thinking and innovation.
- Priority disputes:
  - Newton *vs.* Leibniz over the calculus (1600's).
  - Joule *vs.* Mayer over mechanical equivalent of heat (1860's).
  - Celera Genomics *vs.* Human Genome Project (2001).



## C. Deviant Behavior

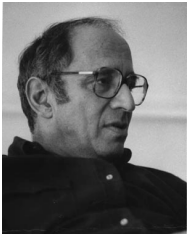
- Fraud.
  - Jan Hendrik Schön's organic molecular transistor.
    - Schön, Meng, Bao (2001) "Self assembled monolayer organic field-effect transistors", *Nature* **413**, 713-716.
    - Schön, Meng, Bao (2001) "Field-Effect Modulation of the Conductance of Single Molecules", *Science* **294**, 2138-2140.
    - Schön, Kloc, Batlogg (2001) "Universal Crossover from Band to Hopping Conduction in Molecular Organic Semiconductors", *Phys. Rev. Lett.* **86**, 3843-3846.
  - Irregularities found in noise data.
  - 2002: Schön fired from Bell Labs. Articles retracted from journals.

- The "Matthew Effect".
  - All things being equal, scientists with more initial recognition tend to receive more additional recognition than scientists with less initial recognition.

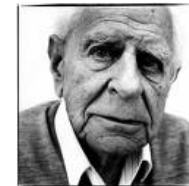
*"For whosoever hath, to him shall be given, and he shall have more abundance: but whosoever hath not, from him shall be taken away even that he hath."*

## Criticism

- (a) *Are Merton's norms descriptive of actual scientific practice?*
- How prevalent is "deviant behavior"?
    - Is it an accidental or essential characteristic of scientific practice?
  - How prevalent is organized skepticism?



*Normal science is characterized by a balance between open-mindedness and dogmatism!*



*Harumph!*

(b) *Are Mertonian norms prescriptive of "good" scientific practice?*

- Communalism, disinterestedness, and *entrepreneurial science*.
- Which venue best supports scientific research: industry or academia?

***Industry:***

*Advantages:*

- More resources.
- Chance to see ideas embodied in products.
- Compensation.
- Less individual competition.

*Disadvantages:*

- Less control over projects.
- Less individual freedom.
- More institutional competition.
- Less job security.

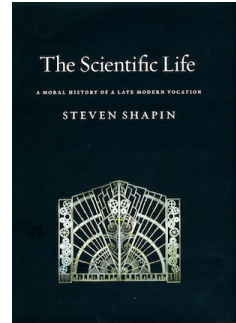
***Academia:***

*Advantages:*

- More control over projects.
- More individual freedom.
- Less institutional competition.
- More job security.

*Disadvantages:*

- Less resources.
- Less time for research (teaching, grant writing).
- Compensation.
- More individual competition.



S. Shapin (2008)  
*The Scientific Life*

## 2. The Strong Programme and the Sociology of Scientific Knowledge (1970's Univ. Edinburgh)



David Bloor



Barry Barnes



Donald MacKenzie

Concern: How does scientific knowledge arise in a social context?

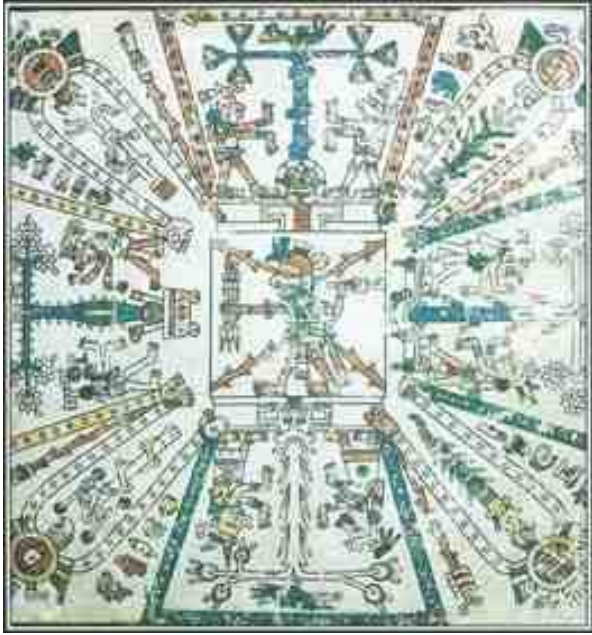
### Four Tenets (Bloor 1976)

- (i) *Causality:* Concerned with the causal conditions which bring about belief or states of knowledge.
- (ii) *Impartiality* with respect to truth and falsity, rationality or irrationality, success or failure.
- (iii) *Symmetry in Explanation:* All forms of belief and behavior should be approached using the same kinds of explanation.
- (iv) *Reflexivity:* Should be applicable to sociology itself.

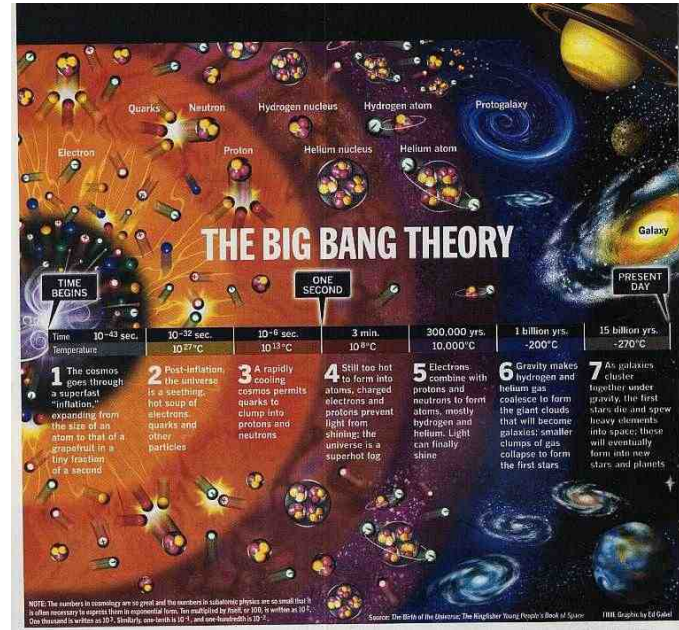
- Idea: Scientific beliefs are established and maintained by local social norms just like other types of beliefs.
- In particular: Scientific beliefs are on equal status with other types of beliefs (no reference to the "real world" should privilege scientific beliefs over others).



Strong Claim: There is no single set of standards entitled to govern the justification of beliefs (*relativism of standards of justification*).



*Aztec belief system*



*21st cent. scientific belief system*

- Justification of a belief system is internal to that system, not external.



Harumph!



Harumph!

*Social Constructivist Thesis:*

Science is a social phenomenon in two respects:

- (1) The *manner* in which it produces results.
- (2) The *results* themselves: *scientific facts are "socially constructed"*.

*What does "socially constructed" mean?*

???

**1. Social reality is socially constructed.**

*To construct X in the social world requires:*

- Knowledge of *X* encourages behaviors that increase or reduce other people's tendency to act as though *X* does or does not exist.
- There is reasonably common knowledge of *X*
- There is transmission of knowledge of *X*.

- *Ex:* gender, baseball



**2. Things and phenomena are socially constructed.**

*Ex:* The artifacts of laboratories and experiments are non-natural constructs of social structures and organizations.



**3. Material and social environments are scientifically and technologically constructed.**

*Ex:* The development of gas-powered automobiles constructed suburbs and suburban culture and society.

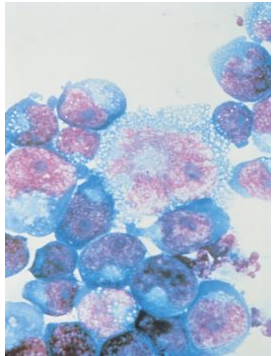


**4. Scientific theories are socially constructed.**

*Ex:* The theoretical claims made by theories are typically underdetermined by evidence.

**5. The simultaneous shaping of the material and social world (*heterogeneous construction*).**

*Ex:* The development of the Pap smear test for uterine and cervical cancer (CC98).



**6. Natural kinds are socially constructed (*nominalism*).**

*Ex:* water, human, tiger, triangle, etc.

## 7. Nature is socially constructed.

*How might we make sense of this?*

### Social Constructivist Thesis:

Science is a social phenomenon in two respects:

- (1) The *manner* in which it produces results.
- (2) The *results* themselves: *scientific facts are "socially constructed"*.

- Problem: Big risk of running Claims (1) & (2) together. This conflates a *methodological* claim with an *ontological* claim:

- (a) *Methodological claim:* The *methods* used by science are socially influenced (peer review, grant process, institutional politics, *etc.*)
- (b) *Ontological claim:* The *products* of science (*i.e.*, facts) are social constructs.

- Claim (a) is not controversial.
- But: Evidence for Claim (a) is not evidence for Claim (b). To substantiate Claim (b) requires arguments based on *ontological* premises.

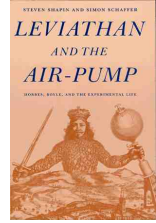
Option #1 (Empiricism): "Socially constructed" means "Explainable solely in terms of social parameters".

- Requires a *theory of social causation* = a causal account of how knowledge arises in which *only* social parameters occur.
- One possibility: Show that scientific facts *supervene* on social facts. For every scientific fact, there are social facts that are *necessary* and *sufficient* conditions for it.

Option #2 (Neo-Kantian): "Socially constructed" means "Constructed in a Kantian sense".

- Recall: Kant maintained that the world of experience (the phenomenal world) is constructed by us.
- And: Kant maintained that the manner in which we construct the phenomenal world is fixed (everyone has the same built-in "filters").
- Suppose: The filters are not built-in, but determined by social factors.

Example: *Leviathan and the Air Pump* (Shapin & Schaffer 1985)



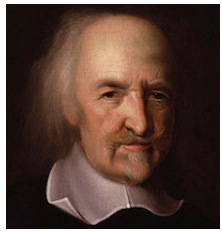
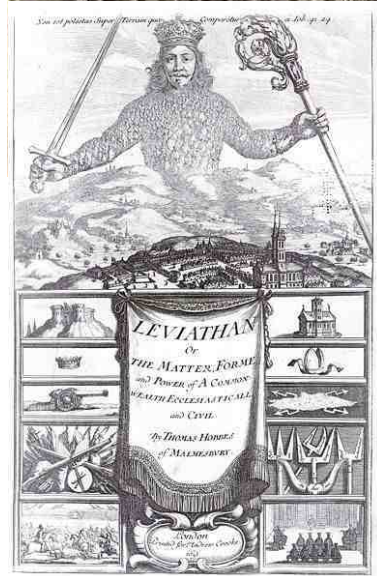
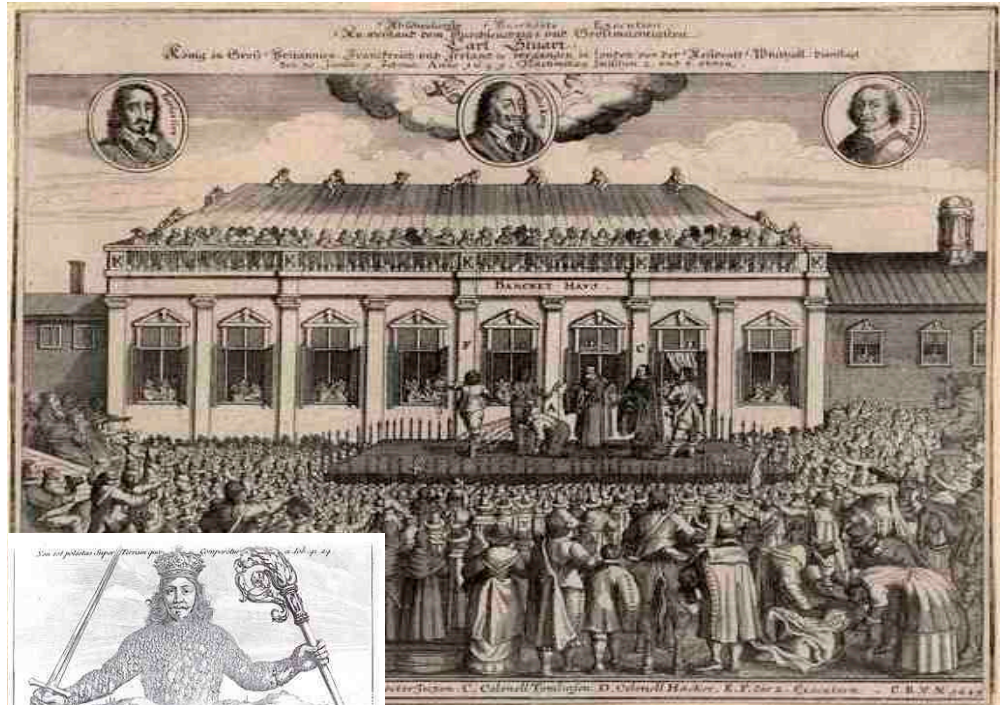
Steven Shapin



Simon Schaffer

Claim: Scientific facts are not absolute but rather depend on cultural and political contingencies.

- 17th century Britain:
  - Civil war!
  - King Charles beheaded!
  - Chaos and Cromwell!
- Hobbes (1651) *Leviathan*.
  - Life in the state of nature is "solitary, poore, nasty, brutish, and short".
  - An absolute monarch is necessary to bind humans together in a society.



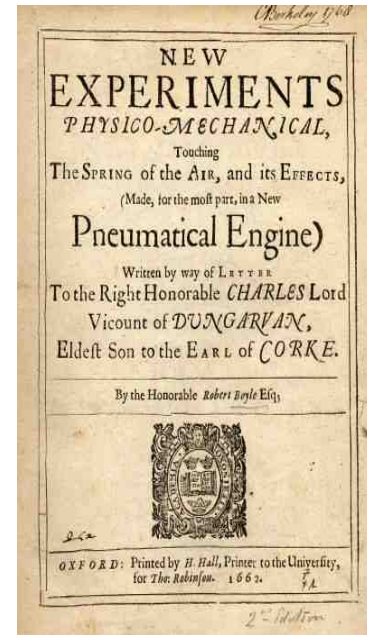
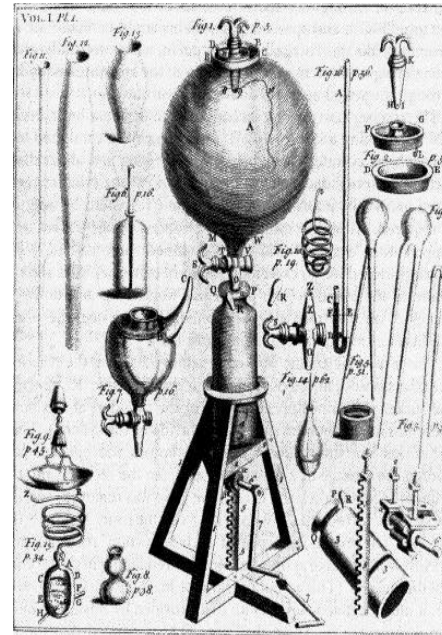
Thomas Hobbes  
1588-1679





Robert Boyle  
1627-1691

- Robert Boyle
  - Founding member of the Royal Society (1660).
  - To maintain social order, make a division between:
    - Public sphere: The *experimental investigations* of matters of fact, which should be public and cooperative.
    - Private sphere: The construction of *theoretical explanations* of matters of fact, which can be done in private.
- Example: Boyle's experiments on the vacuum.
  - Hobbes (Aristotlian physics): a vacuum is a metaphysical impossibility.
  - Boyle's response: The question is not "Can an absolutely pure vacuum exist?", but rather "Can we approximate a vacuum in a given piece of experimental equipment?"
- Boyle rephrases questions to separate *public* experimental investigations from *private* metaphysics and theology.



Wittgensteinian concepts:



- *form of life* = basic set of practices, behaviors, principles (no external justification).
- *language game* = pattern of linguistic habits associated with a form of life.
- *Use theory of meaning:*
  - Language does not represent; rather, it is used by communities to communicate.
  - Terms do not gain meaning by what they represent; rather, they gain meaning by how they are used.

- Boyle set up a new language game for the form of life of experimental science.

"The form of life in which we make our scientific knowledge will stand or fall with the way we order our affairs in the state."

"... it is ourselves and not reality that is responsible for what we know. Knowledge, as much as the state, is the product of human actions."

# Casper, M. & Clarke, A. (1998) 'Making the Pap Smear into the "Right Tool" for the Job: Cervical Cancer Screening in the USA, circa 1940–95'



Monica  
Casper

Adele  
Clarke

- Criteria for good public health screening test: *fast, cheap, accurate*.
- Pap smears used since 1940s to screen for cancer of the uterus and cervix.

Claim: At its inception the Pap smear was neither fast, cheap or accurate.

- Question: Why and how did it become the most widely used and entrenched cancer-screening technology in the world?
  - Why? Through the *construction* of "good" science and medicine by private non-profit charities.
  - How? Through local "*tinkering*" practices among clinicians, technicians, and outside agencies.

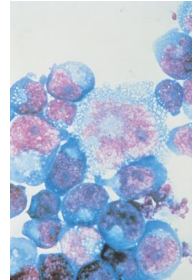


# Why the Pap smear became the "right" tool for the job



George  
Papanicolaou  
(1883-1962)

- 1917. George Papanicolaou publishes paper on oestrous cycle in guinea pigs.
  - *Cytology = study of exfoliated (free-floating) cells.*
  - *Vaginal smears of guinea pigs provide reliable indicator of oestrous cycle.*
- 1920s. Resistance to Papanicolaou's attempt to extend smear tests ("Pap smears") to women as indicator of uterine and cervical cancer.
  - *"Adding cytological analyses to extant facilities seemed particularly overwhelming in that most slides (about 75%) were expected to be 'normal'."*
- 1940s. Newly renamed and reorganized American Cancer Society (ACS); National Cancer Institute (NCI) revitalized at same time.
  - *"The Pap smear appealed to ACS leaders as a simple technique that could help fulfill their slogan without the need for elaborate or expensive new technologies—the right tool for the chosen job."*



*"Every Doctor's  
Office a Cancer  
Detection Center"*

"In sum, the Pap smear was a technology that 'fit' with the early intervention (rather than prevention) goals of major actors in the cancer arena, the ACS and the NCI, which certainly enrolled it and Papanicolaou as allies, and promoted them relentlessly for many years." (CC98, pg. 262.)

## Three Problems with Pap Smear

### Steps in Pap smear test:

- (a) Clinician (doctor or nurse) collects sample and affixes it to glass slide.
- (b) Slide sent to a cytology lab and analyzed by a cytotechnician, typically a woman college graduate with one year of training.
- (c) Cytotechnician scans each of 50,000–300,000 cells per slide for abnormalities.
- (d) Slides with abnormalities are sent to a pathologist (typically male) for review.
- (e) Slide is classified and reported back to clinician.

### 1. Chronic ambiguities about what cancer is.

- *No conclusive means of predicting whether cellular changes will regress to 'normal', remain static in 'non-normal state', or progress to invasive cancer.*

### 2. Chronic ambiguities of classification.

- *Goal is global standards, but in practice divergent classificatory schemes and "work arounds" and "tinkering" at many levels.*

**False negative rate:**  
15-40% or even 50%

### 3. Chronic ambiguities in reading slides.

- *Takes a long time; requires concentrated effort; very detailed (requires examination of free-floating exfoliated cells, each of which is unique).*

"In order to work as the right tool for the job of cervical cancer screening, the Pap smear had to become embedded in work arrangements, and in the technological arena in which it was used. In short, it had to be *made into* a tool that would work well enough for the purposes at hand." (CC98, pg. 267.)

# How the Pap smear became the "right" tool for the job: Tinkering strategies

## (i) Gendering the division of labor.

- *Using lower-paid women workers wherever possible.*
- *Hierarchical lab organization: female technicians perform 90% of screenings without assistance of (typically male) pathologists, who are called only for abnormalities.*



"What qualifications should the cytotechnician have? It has been my experience that her personal qualifications are much more important than her academic achievements. These personal qualifications are first, and most important, a real sense of responsibility, ability to maintain a high standard of attention for rather long intervals of time, and, finally, the visual ability to distinguish fine differences in detail." (Graham, Ruth 1956 'Operation of a Training Center for Cytology')

"These personal qualifications vividly echo those specified for domestic servants, as does the routine surveillance of their activities and character." (CC98, pg. 269.)

(ii) Automating the division of labor.

- *Automated screening devices, automated data storage techniques.*

(iii) Cost juggling.

- *Charge more for other tests to keep Pap smear costs down (gives appearance of satisfying the "cheap" criterion for mass screening procedures).*

(iv) Abandoning global accuracy for locally negotiated order.

- *Instead of global standards of classification or accuracy, there are local working arrangements between clinicians, technicians and pathologists.*

(v) Exploring alternatives to Pap smear screening.

- *Most too expensive for mass screening.*

(vi) Activism: women's health movement, public health activists.

- *Bring to light scandals in 1970s-80s over high rate of false negatives.*

"..we play off the commonsense assumption that technologies work relatively well and relatively easily, or else they would not be in widespread use. The Pap smear is one technology which refutes this assumption rather vividly." (CC98, pg. 258.)

"...the history of the Pap smear, like the history of most biomedical tools, is a history of compromise and making do." (CC98, pg. 258.)

"Our account, grounded in a social worlds/arenas framework, challenges the notion of 'system' or 'network' by emphasizing the multiplicity of perspectives of actors and their social worlds, and the non-systematic aspects of interaction, such as tinkering and locally negotiated orders in the Pap smear arena." (CC98, pg. 276.)

*Social worlds approach:*

- Complex interconnected technoscientific arena involved in the technology of the Pap smear, including both humans and non-human actors.
- But not completely symmetrical: some human actors and their social arenas are treated differently than non-human actors, and even other human actors.

"While the Pap smear's role as a 'non-human actor' in this arena is central, we disagree with actor-network theorists that it should be analyzed symmetrically with 'human' actors, or even that all human actors should be accorded the same *analytic* stature." (CC98, pg. 257.)

*Actors for whom the Pap smear was the right tool for the job:*

- American Cancer Society, National Cancer Institute.
- George Papanicolaou.
- The field of medical cytology (as opposed to medical pathology).
- Women patients for whom precancer was detected and successfully treated.

*Actors for whom the Pap smear was the wrong tool for the job:*

- Women cytotechnicians.
- Women diagnosed with false negatives (failed detection of cancer).
- Women diagnosed with false positives (incorrect detection of cancer).

"The rightness of the Pap smear has had to be continually negotiated, maintained and restored via the multiple tinkering strategies discussed here..." (CC98, pg. 276.)

"Thus the 'rightness' of a tool may be constantly constructed and reconstructed in diverse ways, at multiple levels of social organization, by actors with a multiplicity of perspectives, operating in complicated social worlds, with diverse interests and agendas, which may all be varyingly addressed over time." (CC98, pg. 276.)