

PORTLAND STATE UNIVERSITY  
Systems Science Ph.D. Program  
Professor Martin Zwick  
(503) 725-4987

**Fall 2006**  
MW 4:00 - 5:50  
Harder House 104  
zwick@pdx.edu

## **SYSTEMS PHILOSOPHY (SySc 521-621)**

Relevant papers at <http://www.sysc.pdx.edu/faculty/Zwick/research.html>

This seminar will consider some philosophical issues central to the systems field. Fundamental to these issues is Bunge's conception of systems science as a research program aimed at the construction of "an exact and scientific metaphysics," that is, a set of concepts, models, and theories of broad generality and philosophical import, which are applicable to the sciences, and which are cast (or capable ultimately of being cast) in the exact language of mathematics.

The course will present a broad range of systems ideas (from information theory, game theory, thermodynamics, non-linear dynamics, decision theory, and many other areas) and attempt to integrate these ideas into a coherent framework. These ideas will be organized around the theme of fundamental "problems," that is, difficulties (imperfections, modes of failure) encountered by many systems of widely differing types. While most of these ideas are mathematically-based, they will be approached in this course primarily at a conceptual level (with mathematical details provided as requested). Many of these systems ideas derive from the natural sciences and engineering, but they apply as well to the social sciences and to fields of professional practice (business, the helping professions, etc.). It is primarily their relevance to the human domain – to individuals, groups, organizations, and societies – and to technology which motivates this theoretical/philosophical inquiry. Certain of these ideas pertain also to the arts and humanities.

This course draws from the literature of general systems theory and cybernetics, which launched the systems research program, and from the literature of chaos, complexity, and complex adaptive systems which continues this program today. While the contemporary renaissance of systems theory has brought major advances, the older "classical" tradition of GST/cybernetics articulated the systems project in a deeper way. Seminal writings of both classical and contemporary systems scientists (e.g., Boulding, Deutsch, Emery & Trist, Jantsch, Laszlo, Bateson, Wiener, Holland, Gell-Mann, Crutchfield, Arthur) will be discussed.

Readings will be from (1) the manuscript of a book (working title: *Elements and Relations*) being written by the instructor, which attempts the integration spoken of above, (2) a collection of xeroxed articles and selections from books, and (3) a Scientific American Reader in Systems Theory & Complex Systems, all obtainable at SmartCopy, 1915 SW 6th (227-6137).

Course work: term paper ( 25 dbl.-sp. pages + bibl.); class participation; supplementary short writing assignments

Prerequisites: graduate status in Systems Science or permission of instructor. This is a seminar course with limited enrollment, so SySc students have first priority.

Course Outline: ER = Elements & Relations; X = xeroxed articles, S= SciAm Reader; { } = assignments

- Sept 25 Introduction & overview; immersion: reading from *ER* Essay
- Sept 27 The systems paradigm  
*ER*: Preface, Commentary 1-4 (pp. 3-4, 31-119); [*optional*: Zwick (TOP,UI)]
- Oct 2,4 “*exact & scientific metaphysics*”; *basic systems ideas; challenge of unity*  
*X*: Bunge, Boulding, von Bertalanffy, Ashby  
*S*: Ruthen, Horgen, Wakefield
- Oct 2 Guest lecturer: Prof. Tom Seppalainen, Dept. of Philosophy {Oct 4:  
#1}
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- Oct 9,11 Synchronics: Incompleteness, Constraint, Distinction {Oct 11: #2}  
Oct 16,18 *set- & info-theory; graph theory; dynamics*  
*ER*: *Synchronics*, Sections 1-3 (pp. 5-7 [Essay], 158-224 [Notes])  
*X*: Zwick (WP), Feibleman & Friend *S*: Crutchfield, Kosko, Kauffman, Jurgens
- Oct 23,25 Synchronics: Persistence, Identity {Oct 25: #3}  
*catastrophe theory; stability, regulation, & control; thermodynamics*  
*ER*: *Synchronics*, Sections 4-5 (pp. 7-9 [Essay], 225-242 [Notes])  
*X*: Wiener, Deutsch, Jantsch *S*: Zeeman
- Oct 25 Paper topic declarations**
- Oct 30,Nov 1 Synchronics: Agency  
*game/decision theory*  
*ER*: *Synchronics*, Sections 6-9 (pp. 9-14 [Essay], 243-271 [Notes])  
*X*: Elster, Emery & Trist, Rapoport *S*: Swets, Nowak, Smith
- Nov 6,8 Synchronics: Complexity, Adaptation, Summary  
*hierarchy/networks, modeling subsystem, dualities*  
*ER*: *Synchronics*, Sections 6-9 (pp. 15-19 [Essay], 272-291 [Notes])  
*X*: Koestler, Zwick (ICM), Bateson, Gell-Mann, Marcus *S*: Barabasi, Bonabeau, Blackmore
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- Nov 13,15 Diachronics: Origins, Development, Limitation, Complexification {Nov 13: #4}  
*system formation, growth/development, segregation/systematization*  
*ER*: *Diachronics*, Sections 1-4 (pp. 20-25 [Essay], 292-317 [Notes])  
*X*: Zwick (HBL), Arthur *S*: Arthur
- Nov 20,22 Diachronics: Internal Opposition, Environment, Change, Impermanence  
*transformation, self-organized criticality, limits to growth, evolution*  
*ER*: *Diachronics*, Sections 5-8 (pp. 25-30 [Essay], 318-332 [Notes])  
*X*: Zwick (DC), Forrester, Laszlo *S*: Holland, Bak
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- Nov 27 Term papers due; 1-page abstracts to be distributed** {Nov 29: #5}
- Nov 29,Dec 4 Science/Religion/Politics: Relevance of ST to social systems; Auto-critique  
*ER*: Commentary 5 (pp. 120-157), Appendix (pp. 333-344)

COLLECTION OF XEROXED ARTICLES AND SELECTIONS FROM BOOKS (X)

\*Also available at [http://www.sysc.pdx.edu/faculty/Zwick/research.html#Systems Philosophy](http://www.sysc.pdx.edu/faculty/Zwick/research.html#Systems%20Philosophy) (Articles are in the order used in the course.)

Bunge, Mario. *Method, Model and Matter*. D. Reidel, Boston, 1973: Ch. 2 (Testability Today), Ch. 8 (Is Scientific Metaphysics Possible), [*Optional*: Ch. 5 (Concepts of Model)]

Boulding, Kenneth, "General Systems Theory - The Skeleton of Science." *Management Science* 2, 197-208, 1956.

von Bertalanffy, Ludwig. "General System Theory - A Critical Review." *General Systems* VII, 1-20, 1962.

Ashby, W. Ross. "What is New" (Ch. 1). *An Introduction to Cybernetics*. Methuen, London, 1964.

\*Zwick, M. "Towards an Ontology of Problems" (TOP)" *Advances in Systems Science and Applications*, 1, pp. 37-42, 1995.

\*Zwick, M. "Understanding Imperfection (UI)." In *Proceedings of The World Congress of the Systems Sciences and ISSS 2000*, Allen, J.K. and Wilby, J.M. eds., Toronto, Canada: International Society for the Systems Sciences, 2000.

Zwick, M. "Wholes and Parts in General Systems Methodology." *The Character Concept in Evolutionary Biology*. Günter Wagner, ed., Academic Press, NY, 2001

Feibleman, J. and Friend, J.W. "The Structure and Function of Organization." *Philosophical Review*, 54, pp. 19-44, 1945. Reprinted in Emery, F.E., *Systems Thinking*. op cit. (pp. 30-55)

Wiener, Norbert. "Progress and Entropy" (Ch. II). *The Human Use of Human Beings*. Avon Books, New York, 1967.

Deutsch, Karl W. "The Self-Closure of Political Systems" (Ch. 13). *The Nerves of Government*. The Free Press (Macmillan), New York, 1966.

Jantsch, Erich. "Macroscopic Order" (Ch. 1). "Dissipative Structures:Autopoiesis"(Ch. 2), "Order through Fluctuation: System Evolution" (Ch. 3). *The Self-Organizing Universe: Scientific and Human Implications of the Emerging Paradigm of Evolution*. Pergamon Press, New York, 1980.

Emery, F.E. and Trist, E.L. "The Causal Texture of Organizational Environments." *Human Relations*. 18, pp.21-32, 1965. Reprinted in Emery, F.E., *Systems Thinking*. Penguin Books. New York, 1969. (pp. 241-257)

Elster, Jon. *Ulysses and the Sirens*. Cambridge University Press. pp.viii-47, 1984.

Rapoport, Anatol. "Games." *Peace and Change*, vol. XIII, pp.18-43, 1988.

Koestler, Arthur. *Janus: A Summing Up*. Random House, New York, 1978: Chapter II. "Beyond Eros and Thanatos" & Appendix I. "Beyond Atomism and Holism - The Concept of the Holon."

Bateson, Gregory. "Criteria of Mental Process" (Ch. IV). *Mind and Matter*, Bantam, NY, 1984.

Gell-Mann, Murray. "Complex Adaptive Systems." *Complexity: Metaphors, Models, and Reality* G. A. Cowan, D. Pines, & D. Meltzer, eds., Addison-Wesley, Reading Mass, pp. 17-45, 1994.

\*Zwick, M. "Information, Constraint, and Meaning (ICM)." *General Systems* 29, 41-47, 1986.

Marcus, Solomon. "No system can be improved in all respects." *Systems: New Paradigms for the Human Sciences*, ed. by Gabriel Altmann & Walter A. Koch, Walter de Gruyter, New York, pp. 143-164, 1998.

Arthur, W. Brian. "On the Evolution of Complexity." *Complexity: Metaphors, Models, and Reality*, pp. 65-82, 1994.

\*Zwick, M. "Some Analogies of Hierarchical Order in Biology and Linguistics (HBL)." *Applied General Systems Research: Recent Developments and Trends*, George Klir, ed., Plenum Press, New York, pp.521-529, 1978.

Zwick, Martin. "Dialectics & Catastrophe (DC)." In: *Sociocybernetics*, vol. I, Martinus Nijhoff, Boston, pp. 129-154, 1978.

Forrester, Jay W. "Understanding the Counterintuitive Behavior of Social Systems." Testimony to Committee on Banking & Currency, US House of Representatives, 10/7/70.

Laszlo, Ervin. Introduction, "The Rise of the Evolutionary Paradigm" (Ch. 1), "Foundations of the Grand Synthesis" (Ch. 2) in *Evolution, The Grand Synthesis*. Shambhala, Boston, 1987.

Distributed separately (not in coursepack):

\*Zwick, M. "Incompleteness, Negation, Hazard (INH): On the Precariousness of Systems." *Nature and System*, 6 (1984) 33-42.

## SCIENTIFIC AMERICAN READER in SYSTEMS THEORY & COMPLEX SYSTEMS (Sept 2006)

### I. General:

1. Russell **Ruthen**, *Adapting to Complexity (Trends in Nonlinear Dynamics)*. 1/93: 130-140.
2. John **Horgan**, *From Complexity to Perplexity*. 6/95: 104-109.
3. Julie **Wakefield**, *Complexity's Business Model*. 1/2001: 31, 34

### II. Order/disorder, dynamics:

4. Gregory Chaitin, Randomness and Mathematical Proof. 5/75: 47-52.
5. David Layzer, The Arrow of Time. 12/75: 56-69.
6. Charles H. Bennett, Demons, Engines, and the Second Law. 11/87: 108-116.
7. James P. **Crutchfield**, J. Doyne Farmer, Norman Packard, & Robert Shaw, **Chaos**. 12/86: 46-57.
8. E. C. **Zeeman**, *Catastrophe Theory*. 4/76: 65-83.
9. Daniel L. Stein, Spin Glasses. 7/89: 52-59
10. Per **Bak** & Kan Chen, *Self-Organized Criticality*. 1/91: 46-53
11. W. Brian **Arthur**, *Positive Feedbacks in the Economy*. 2/90: 92-99.

### III. Form, Complexity, Morphogenesis:

12. Nicholas Pippenger, Complexity Theory. 6/78: 114-124.
13. Irvin Rock & Stephen Palmer, The Legacy of Gestalt Psychology. 12/90: 84-90.
14. Leonard M. Sander, Fractal Growth. 1/87: 94-100.
15. Hartmut **Jurgens**, Heinz-Otto Peitgen, & Dietmar Saupe, *The Language of Fractals*. 8/90: 60-67.
16. Karl J. Niklas, Computer-simulated Plant Evolution. 3/86: 78-86.
17. Benoit B. Mandelbrot, A Multifractal Walk down Wall Street. 2/99: 70-73.
18. Shawn Carlson, Boids of a Feather Flock Together. 10/00: 112, 114
19. Moshe Sipper & James A. Reggia, Go Forth and Replicate. 8/01: 35-43.
20. **Barabasi** & Bonabeau, **Scale-Free Networks**. 5/03: 60
21. Taylor, Richard P. Order in Pollock's Chaos. 12/02:117-121.

### IV. Behavior, Rationality:

22. Daniel Kahneman & Amos Tversky, The Psychology of Preferences. 6/78: 160-173.
23. John Maynard **Smith**, The Evolution of Behavior. 9/78: 176-192.
24. Natalie S. **Glance** & Bernardo A. Huberman, The Dynamics of Social Dilemmas. 3/94: 70-81.
25. Douglas H. Blair & Robert A. Pollak, Rational Collective Choice. 8/83: 88-95.
26. John A. **Swets**, Robyn M. Dawes, & John Monahan, *Better Decisions through Science*. 10/00:82-87
27. Martin A. **Nowak**, Robert M. May, & Karl Sigmund, *Arithmetic of Mutual Help*. 6/95: 76-81.
28. Karl Sigmund, Ernst Fehr, & Martin A. Nowak, The Economics of Fair Play. 1/02: 83-87.

### V. Adaptation, Evolution:

29. Richard C. Lewontin, Adaptation. 9/78: 213-230.
30. Stuart A. **Kauffman**, Antichaos and Adaptation. 8/91: 78-84.
31. John **Holland**, *Genetic Algorithms*. 7/92: 66-72.
32. Koza, John R., Martin A. Keane, & Mathew, J. Streeter, Evolving Inventions. 2/03:52-59
33. John Rennie, Living Together. 1/92: 123-133.
34. Jeffrey Kephart, Gregory Sorkin, David Chess, Steve White, Fighting Computer Viruses. 11/97:88-93
35. Eric **Bonabeau** and Guy Therauloz, *Swarm Smarts*. 3/00: 72-79.
36. Susan **Blackmore**, *The Power of Memes*. 10/00: 64-73.

### VI. Computation, Modeling:

37. Stephen Wolfram, Computer Software in Science and Mathematics. 9/84: 188-203.
38. Harry R. Lewis & Christos H. Papadimitriou, The Efficiency of Algorithms. 1/78: 96-109.
39. John E. Hopcroft, Turing Machines. 5/84: 86-98.
40. Robert G. Bland, The Allocation of Resources by Linear Programming. 6/81: 126-144.
41. Bart **Kosko** & Satoru Isaka, *Fuzzy Logic*. 7/93: 76-81.
42. David Tank & John J. Hopfield, Collective Computation in Neuronlike Circuits. 12/87:104-114.
43. W. Wayt Gibbs, Cybernetic Cells. 8/01: 53-57.

Supplementary Assignments: indicated on the syllabus with { }

Each assignment should be **only one page** in length (but do not use a less than 10pt font).

1. What are your interests and/or what would you like to get from this course? {due Oct. 4}
2. How do your specific interests relate to the idea of an “exact and scientific metaphysics.” To the best of your current knowledge, what does – or might – your specific interest area contribute to the systems research program and what does – or might – systems theory contribute to this area? One can obviously write at great length about this, so *please* just select, for this one-page mini-paper, what is most important to you. {due Oct. 11}
3. **Paper topic declaration:** summarize the subject and goals of your term paper. {due Oct. 25}
4. Comment on *one* systems-theoretic idea from the subjects covered in Synchronics or Diachronics or the supporting readings) which does not relate to your term paper. {due Nov. 13}
5. Comment on a religious *or* political implication of systems theory/philosophy (e.g., an idea discussed in E&R Commentary, chapter 5) {due Nov. 29}