History 593

The Sciences of the Artificial

Professor Michael S. Mahoney

(Current Agenda and Readings as of 11/8)

Wednesday, 9:00-11:50	Firestone Library C8L

Week 1 (9/20): 7 Themes and Agenda	Herbert Simon, *The Sciences of the Artificial*, Ch. 1 and overview of overall structure.
Week 2 (9/27): The Natural and the Artificial **Reporter:** Emily Brock	**Primary** Aristotle, *Physics*, Book II Bacon, *The New Organon*, Book I Robert Hooke, *Micrographia,* Preface **Secondary** Peter Dear, *Discipline & Experience,* Ch. 6, "Art, Nature, Metaphor" S. Lelas, "Science as Technology", *Brit. J. Phil. Sci.* 44(1993), 423-42 J.E. Tiles, "Experiment as Intervention", *Brit. J. Phil. Sci.* 44(1993), 463-75 **Background** Paolo Rossi, *Philosophy, Technology, and the Arts in the Early Modern Era* Ian Hacking, *Representing and Intervening*
Week 3 (10/4): The Clockwork Universe **Reporter:** Carla Makler	**Primary** Descartes, *The World, or Treatise on Light*, and *Treatise on Man* Christiaan Huygens, *On the Center of Oscillation* (for other texts on mechanics by Descartes and Huygens, click here) Isaac Newton, *Mathematical Principles of Natural Philosophy*, Preface, Axioms or Laws of Motion, and Book I, Sect. 2 (*passim*) **Secondary** Alan Gabbey, "Newton's *Mathematical Principles of Natural Philosophy*: A Treatise on 'Mechanics'?", in P.M. Harman and A.E.Shapiro (eds),*The Investigation of Difficult Things*, 305-322 Michael S. Mahoney, "The Determination of Time and of Longitude at Sea", in H.J.M Bos, *et al*, *Studies on Christiaan Huygens,* 234-270 Michael S. Mahoney, "The Mathematical Realm of Nature", in D.E. Garber et al.(eds.), *Cambridge History of Seventeenth-Century Philosophy*, Vol. I, pp. 702-55 Otto Mayr, *Authority, Liberty, and Automatic Machinery in Early Modern Europe,* Ch. 3, "The Clockwork Universe"

	Background and Additional References See syllabus for [HIS 591, Spring '97](#) **Esthetic Intellectual Experience** William J.H. Andrewes, *The Quest for Longitude* (Harvard Collection of Historical Scientific Instruments, 1996)
Week 4 (10/11): The World of Energy **Reporter:** Matt Wisnioski	**Primary** Sadi Carnot, *Reflections on the Motive Power of Fire*; E Clapeyron, *Memoir on the Motive Power of Heat*; R. Clausius, *On the Motive Power of Heat* (published togegther by E. Mendoza) Charles Babbage, *On the Economy of Machinery and Manufactures* Joseph Fourier, *Théorie analytique de la chaleur* [1812, 1822]; cf. original versions, "Mémoire sur la propagation de la chaleur avec notes séparées sur cette propagation ... ", in Ivor Grattan-Guiness and J.R. Ravetz, *Joseph Fourier 1768-1830* (Cambridge, MA, 1972) **Secondary** M. Norton Wise, "Work and Waste: Political Economy and Natural Philosophy in Nineteenth Century Britain", *History of Science* 27(1989), 263-301, 391-449; 28(1990), 221-61 Wise, "Mediating Machines", *Science in Context* 2,1(1988), 77-113 **Background and Additional References** Crosbie Smith, *The Science of Energy*
Week 5 (10/18): Cybernetics **Reporter:** Joe November	**Primary** Arturo Rosenblueth, Norbert Wiener and Julian Bigelow, "Behavior, Purpose and Teleology," *Philosophy of Science* 10 (1943): 18-24 Norbert Wiener, *Cybernetics, or Control and Communication in the Animal and the Machine* (Cambridge: MIT, 1948; 2nd ed., 1961) W. Ross Ashby, *An Introduction to Cybernetics* **Secondary** Michael A. Arbib, "A Historical Perspective [on Cybernetics]", in his *Brains, Machines, and Mathematics*, 2nd. ed. Chap. 1 Peter Galison, "The Ontology of the Enemy: Norbert Wiener and the Cybernetic Vision," *Critical Inquiry* 21 (1994): 228-265 David A. Mindell, "'Datum for it Own Annihilation:' Feedback, Contol, and Computing, 1916-1945" (Ph.D., MIT, 1996), Chapter 9 Geof Bowker, "How to be Universal: Some Cybernetic Strategies, 1943-70," *Soc. Stud. Sci*. 23 (1993): 107-27 H. Kalmus, "A Cybernetical Aspect of Genetics," Journal of *Heredity* 41 (1950): 19-22 Robert Trappl, ed. *Cybernetics: Theory and Application* (Washington: Hemisphere, 1983); students should look at the range of fields covered under "Applications" **Background and Additional References** Otto Mayr, *The origins of feedback control* Steven J. Heims, *The Cybernetics Group, 1946-1953: Constructing a Social Science for Postwar America*

Week 6 (10/25): Information Theory **Reporter:** Tania Munz	**Primary** Claude Shannon, *The Mathematical Theory of Communication* Henry Quastler (ed.), *Essays on the Use of Information Theory in Biology* (Urbana: University of Illinois Press, 1953) F. H. C. Crick, "On Protein Synthesis," *Symposium of the Society for Experimental Biology* 12 (1958): 138-63 J.B.S. Haldane, "Data Needed for a Blueprint of the First Organism," in Sideney W. Fox, ed. *The Origins of Prebiological Systems* (Academic Press, 1965) Ken Thompson, "On Trusting Trust", *Communications of the ACM*, 27, 8(1984), 761-763 **Secondary** William Aspray, "The Scientific Conceptualization of Information: A Survey," *Annals of the History of Computing* **7:2** (1985): 117-140 Mindell, Chapter 4 Sahotra Sarkar, "Biological Information: A Skeptical Look at Some Central Dogmas of Molecular Biology," *The Philosophy and History of Molecular Biology: New Perspectives* (Kluwer, 1996), pp. 187-231 Evelyn Fox Keller, "The Body of a New Machine: Situating the Organism Between the Telegraph and the Computer," last essay in *Refiguring Life: Metaphors of Twentieth-Century Biology* (New York: Columbia University Press, 1995). Lily E. Kay, "Cybernetics, Information, Life: The Emergence of Scriptural Representations of Heredity", *Configurations* 5(1997), 23-91; and "Who Wrote the Book of Life? Information and the Transformation of Molecular Biology," *Science in Context* **8** (1995): 609-34. **Background and Additional References** Lila L. Gatlin, *Information Theory and the Living System* (Columbia U.P., 1972), Chaps. 1,6,7 Francois Jacob, *The Logic of Life: A History of Heredity* (Pantheon, English translation 1973, French 1970) John R. Pierce, *An Introduction to Information Theory: Symbols, Signals and Noise* (NY: Harper, 1961; 2nd. rev. ed., NY: Dover, 1980)
FALL BREAK	
Week 7 (11/8): Game Theory and Economics	**Primary** John v. Neumann and Oscar Morgenstern, *Theory of Games and Economic Behavior* (1944), Chapter I **Secondary** Margaret Schabas, "Alfred W. Marshall, W. Stanley Jevons, and the mathematization of economics", *ISIS* 80(1989): 60-73; cf. her *A World Ruled by Number: William Stanley Jevons and the Rise of Mathematical Economics* (1990) Robert J. Leonard, "Creating a context for game theory", in E. Roy Weintraub (ed.), *Toward a History of Game Theory*, 29-76 Philip Mirowski, "What were von Neuman and Morgenstern trying to accomplish?", *ibid.*, 113-147 **Background and Additional References** Philip Mirowski, *More heat than light: Economics as social physics, Physics as nature's economics* (1989) [a controversial book; cf. "Review Symposium on Philip Mirowski's 'More Heat than Light ...", *Philosophy of the Social Sciences* 22(1992), 77-141, esp. the critique of M. Norton Wise]

	Bruna Ingrao and Giorgio Israel, *The invisible hand: Economic equilibrium in the history of science* (1990) Mary S. Morgan, *The history of econometric ideas*
Week 8 (11/15): The Computer and the Church-Turing Thesis **Reporter:** Jane Murphy	**Primary** Warren S. McCulloch and Walter Pitts, "A logical calculus of the ideas immanent in nervous activity", *Bulletin of Mathematical Biophysics* 5(1943), 115-33 (repr. in Warren S. McCulloch, *Embodiments of Mind* (MIT, 1965), 19-39, and in Margaret A. Boden (ed.), *The Philosophy of Artificial Intelligence* (Oxford, 1990), 22-39) John von Neumann, "First Draft of a Report on the Edvac" (1945) and "General and Logical Theory of Automata" (1954) M.S. Mahoney, "Computer Science: The Search for a Mathematical Theory", in J. Echeverria, A. Ibarra and T. Mormann (eds.), *The Space of Mathematics* (Berlin/New York: De Gruyter, 1992), 347-61 Robert Rosen, "Church's Thesis and Its Relation to the Concept of Realizability in Biology and Physics", *Bull. Math. Biophysics* 24(1962), 375-393 Robert Rosen, "Effective Processes and Natural Law", in *The Universal Turing Machine*, ed. R. Herken, 485-98 B. Jack Copeland, "The Church-Turing Thesis", *Stanford Encyclopedia of Philosophy, s.v.* **Background and Additional References** Andrew Hodges, *Alan Turing, The Enigma* (visit Hodge's extensive Turing home page, which includes a link to a working Turing Machine applet) William Aspray, *John von Neumann and the Origins of Modern Computing*
Week 9 (11/22): Artificial Intelligence **Reporter:** Craig Cornelius	**Primary** Alan M. Turing, "Computing Machinery and Intelligence", *Mind* 59(1950), 433-60 John McCarthy, Marvin Minsky, Nathaniel Rochester, Claude E. Shannon, *A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence*(1956) Marvin Minsky, "Steps Toward Artificial Intelligence", in Edward Feigenbaum and Julian Feldman, *Computers and Thought* (1963), 406-450. "Artificial Intelligence: A Debate" (John Searle vs. Paul and Patricia Churchland), *Scientific American* (January 1990), 25-37 Simon, Chaps. 3-4 **Secondary** Allen Newell, "Intellectual Issues in the History of Artificial Intelligence", in Fritz Machlup and Una Mansfeld (eds.), *The Study of Information: Interdisciplinary Messages*, 187-227 **Background and Additional References** Margaret A. Boden (ed.), *The Philosophy of Artificial Intelligence* (includes Turing's and Searle's papers) Hubert L. Dreyfus, *What Computers Can't Do* (Harper & Row, 1972) Marvin Minsky, *The Society of Mind* (Simon and Schuster, 1986) Daniel Crevier, *AI: The Tumultuous History of the Search for Artificial Intelligence* (Basic Books, 1993)
Week 10 (11/29): Models of Growth	**Primary** Noam Chomsky, "On certain formal properties of grammars", *Information and Control* 2,2(1959), 137-167

	Aristide Lindenmayer, "Mathematical models for cellular interactions in development", *J. Theor. Biol.* 18(1968), 280-99, 300-15 Cf. his L-systems(An L-system Tutorial) John H. Holland, "Studies of the Spontaneous Emergence of Self-Replicating Systems Using Cellular Automata and Formal Grammars," in A. Lindenmayer and G. Rozenberg (eds.), *Automata, Languages, Development* (Amsterdam, 1976) Edward F. Moore , "Gedanken-experiments on sequential machines", in *Automata Studies*, ed. Claude Shannon and John McCarthy (Princeton: Princeton University Press, 1956), 129-153. [re: Lindenmayer's statement (p.281), "We assume a 'blackbox', or in more recent terms a 'sequential machine', ..."] **Secondary** Noam Chomsky, *The Logical Structure of Linguistic Theory*, 1-53 ("Introduction 1973") Sheila A. Greibach, "Formal languages: Origins and directions", *Annals of the History of Computing* 3,1(1981), 14-41 **Background and Additional References** Gary William Flake, *The Computational Beauty of Nature* Przemyslaw Prusinkiewicz and Aristid Lindenmayer, *The Algorithmic Beauty of Plants* (Springer Verlag, 1990), esp. Chap.1 John H. Holland, *Hidden Order: How Adaptation Builds Complexity* Terrence W. Deacon, *The Symbolic Species : The Co-Evolution of Language and the Brain* (for a critique of Chomsky's basic premise)
Week 11 (12/6): Cellular Automata and Adaptive Systems Artificial Life **Reporter:** James Platts-Mills	**Primary** Christopher Langton, "Artificial Life", in Margaret A. Boden (ed.) *The Philosophy of Artificial Life*, Chap. 1 Thomas S. Ray, "An Approach to the Synthesis of Life", *ibid*., Chap. 3; see the Tierra home page and get a copy of the software John Maynard Smith, "Evolution -- Natural and Artificial" *ibid*., Chap. 5 Elliott Sober, "Learning from Functionalism -- Prospects for Strong Artificial Life", *ibid*., Chap. 14 John L. Casti, "Newton, Aristotle and the Modeling of Living Systems", in John Casti and Anders Karlqvist (eds.), *Newton to Aristotle: Toward a Theory of Models for Living Systems*, 47-89 Walter Fontana, Günther Wagner, Leo W. Buss, "Beyond Digital Naturalism", in Christoper G. Langton (ed.), *Artificial Life: An Overview*, 211-228 (online version [requires PostScript viewer and/or printer]) **Secondary** Claus Emmeche, *The Garden in the Machine: The Emerging Science of Artificial Life* **Background and Additional References** Richard Doyle, *On Beyond Living: Rhetorical Transformations of the Life Sciences*, Chap. 7, "Emergent Power: Vitality and Theology in Artificial Life" Stefan Helmreich, *Silicon Second Nature: Culturing Artificial Life in a Digital World* John L. Casti, *Alternate Realities: Mathematical Models of Nature and Man*, Chap. 2
Week12 (12/13): A Philosophy of Complexity	**Secondary** Simon, Chap. 7 Cilliers, *Complexity and Postmodernism: Understanding Complex Systems* (London/NY, 1998)

Background and Additional References
John M. Ellis, *Against Deconstruction*
Laura Landweber's Freshman Seminar on DNA Computing