

SYLLABUS

Science: Method, Myth, Metaphor?

Instructor: Amy lone

Objectives

This course investigates how scientific theories and applications have changed over time. Special attention will be given to: (1) developing an understanding of scientific perspectives and methods, (2) developing an understanding of the science/humanities distinction and considering whether it is now a reflection of historical divisions between natural and moral philosophy, (3) exploring how creativity and innovation have changed our perceptions of natural and human patterns of relationship, (4) conceptualizing how scientific models are amenable to quantification and measurement, and (5) considering how the scientific approach compares and connects with other ways of envisioning reality.

No background in science, religion, philosophy, or mathematics will be assumed.

Texts

Debus, A. G. (1992). *Man and nature in the Renaissance*. Cambridge: Cambridge University Press.

Olson, R. (1982). *Science deified and science defied, volume 1*. Berkeley and Los Angeles: University of California Press.

Wallerstein, I. (1996). *Open the social sciences: report of the Gulbenkian Commission on the restructuring of the social sciences*. Stanford: Stanford University Press.

Course Reader: Order from Central Services.

Note:

You will need the reader for some of the early reading assignments.

Weekly Discussion Topics

Week 1 **Introduction of key terms, ideas, and course themes**

Introductory discussion. What is science? The difference between science and scientism. What does it mean to 'understand' the history of science? Does science have a method? Do we need to re-evaluate science today?

Week 2 **Where does the history of science begin?**

The cross-cultural foundations of science. What do we mean by 'western' science? The relationship between science and other ways of knowing the world. Discussion of paradigms, falsification, verification, and clarification. Scientific models: comparing and contrasting linear, cyclic, paradigmatic, systemic, and evolutionary models.

Olson: 1-62

Reader:

Scientific American Profiles: Popper, Kuhn, Feyerabend

Holton, "Einstein and the cultural roots of modern science" *Daedalus: Science in culture*

Kuhn, "Second Thoughts on Paradigms" *The essential tension*

Week 3

Greek views of nature

Origins and techniques of Greek science: a consideration of natural philosophy, logic, and observation. Why does science pose questions differently than other modes of inquiry and model problems with mathematics?

Reader: Osen, *Women In Mathematics*, "History" and "Hypatia"

Olson, pp. 62-181

Week 4

Imaging and Understanding

Perception and method. Reframing scientific ideas about the physical world.

Reader: Montgomery, *The Scientific Voice*, "Seeing and Naming the Skies -- The Case of the Moon"

Galileo, *Siderius Nuncius* (*The Starry Messenger*)

Week 5

The construction of western science

The interpenetration of science and religion in forming the Newtonian model. An introduction to models of the solar system. Non-Western influences on modern science(continued). How humanistic movements in the early Renaissance informed the rise of science: the social and intellectual context for humanism.

Olson, pp. 181-290

Week 6

Models and scale

The atomistic model and the emergence of modern chemistry in the eighteenth century. Historical alternatives to the atomistic model and why they were put aside in the eighteenth century. Discussion of how physics and chemistry inform and use the atomistic model. How the atomistic model has been challenged by the evolution of physics into the twentieth century. Introduction to optical and non-optical technology.

Debus:

1-101

Week 7

New Views of Systems and life

Historical views of the world as a living system. Nineteenth century views of thermodynamics, biology, evolution, psychology.

Debus,

101-141

Reader:

Selections from *Evolution: the history of an idea* (Bowler) and S.J. Gould

Week 8

Scientific invention: mathematics

The difference between mathematical and non-mathematical views of physicality (reality). Why non-Euclidean geometry had an impact as revolutionary as the heliocentric theory, Newton's law of gravitation and Darwin's theory of evolution.

Reader: Selections from Osserman and Stewart

Week 9

The emergence of the social sciences

The emergence of the social sciences. Can we apply science to society?

Wallerstein. *Open the Social Sciences*

Week 10

The scientific imagination: DNA and medical imaging technologies

How scientific invention compares and connects with other ways of envisioning reality. The difference between science and technology. Review and more discussion of optical and non-optical technologies.

Reader: "Rosalind E. Franklin" from Nobel Prize Women in Science
Selections from Kevles, *Naked to the bone: medical imaging in the twentieth century*
Daston, "Fear and loathing of the imagination in science," *Daedalus: science in culture*

Week 11

Conclusion

How do science and culture interpenetrate? Does science have a 'Western' bias? Do values and ethics inform science? Science studies? Are gender and consciousness relevant to science? Will science discover how it all works?

Reader:

Nobel Prize Women in Science, "The Passion of Discovery"

Tsou, C.-L. (1998). *Science and scientists in China*. Science

Chalmers, D. "The Puzzle of Consciousness" *Scientific American*

Crick, F and Koch, C. "Why Neuroscience May be Able to Explain Consciousness," *Scientific American*

Assignments and Grading

Each student will be required to submit two short essays and a final paper.

The essays (3-5 pages) are to be based on the readings and class discussion. Each essay is worth 20% of your overall grade. The first essay is due on October 23rd (the fourth week). The second essay is due on November 20th (the eighth week). Each of these minipapers ought to demonstrate a general understanding of the readings and the topics discussed in class. Essay questions will be handed out the first day of class.

The final paper (10-12 pages) accounts for 50% of the overall grade. This is to be a research paper, complete with references, on a topic of your choice. It is due the last day of class, December 11, 1995. Please draft a one page outline of the paper by the ninth week so that the instructors can approve your topic and project design. This will also allow us to give you feedback and help you organize your research. It is acceptable for your final paper to be an expansion of one of your earlier essays.

General classroom participation, attendance/attitude will make up the remaining 10%. Graduate students will be expected to undertake more ambitious projects than undergraduates.

Letter grade. A = 90% and above. B = 75% - 89%. C - 60% - 74%.

Note:

Class attendance is important. Students are advised that more than one absence will adversely effect the course grade.

Books of Special Interest

Abbott, E. A. (1963). *Flatland*. New York: Dover Publications, Inc.

Barbour, I. G. (1974). *Myths, models, and paradigms*. San Francisco: HarperCollins Publishers.

Basalla, G. (1988). *The evolution of technology*. Cambridge: Cambridge University Press.

Beck, R. N. (1994). *The Future of Imaging Science*. In T. S. a. J. Umiker-Sebeok (Ed.), *Advances in Visual Semiotics – The Semiotic Web* (pp. 609-642). Berlin: Walter de Gruyter, Mouton Publications.

Bohm, D. (1993). *Causality and chance in modern physics*. Philadelphia: University of Pennsylvania Press.

Bonola, R. (1955). *Non-Euclidean Geometry: a critical and historical study and its development* (Carslaw, H. S., Trans.). New York: Dover Publications, Inc.

Boorstein, D. J. (1985). *The discoverers*. New York: Vintage Books.

Bowler, P. J. (1989). *Evolution: the history of an idea*. Berkeley and Los Angeles: University of California Press.

Brooke, J. H. (1991). *Science and religion: some historical perspectives*. Cambridge: Cambridge University Press.

Guillen, M. (1994). *Five equations that changed the world*. New York: Hyperion.

Burt, E. A. (1954). *The metaphysical foundations of modern science*. Garden City: Doubleday Anchor Books.

Butterfield, H. (1957). *The origins of modern science 1300-1800*. New York: The Free Press.

Eddington, A. (1928). *The nature of the physical world*. Cambridge: University Press.

Feyerabend, P. K. (1988). *Against method*. London: Verso.

Galilei, G. (1953). *Dialogue concerning the two chief world systems*. Berkeley: University of California Press.

Galilei, G. (1957). *Discoveries and Opinions of Galileo*. Garden City, New York: Doubleday Anchor Books.

Galison, P. L. (1997). *Image and logic: a material culture of microphysics*. Chicago and London: The University of Chicago Press.

- Goswami, A. (1995). *The self-aware universe*. New York: Jeremy P. Tarcher/Putnam.
- Gould, S. J. (1977). *Ever since Darwin*. New York: W.W. Norton & Company, Inc.
- Gould, S. J. (1996). *Full house: the spread of excellence from Plato to Darwin*. New York: Harmony Books.
- Grant, E. (1977). *Physical science in the Middle Ages*. Cambridge: Cambridge University Press.
- Graubard, S. R., editor. (Winter 1998). *Daedalus: Science in culture*. *Proceedings of the American Academy of Arts and Sciences*, 127:1.
- Hadamard, J. (1973). *The mathematician's mind: the psychology of invention in the mathematical field*. Princeton: Princeton University Press.
- Hankins, T. L. (1985). *Science and the Enlightenment*. Cambridge: Cambridge University Press.
- Harth, E. (1993). *The creative loop: how the brain makes a mind*. Reading, MA: Helix Books.
- Harvey, W. (1993). *The circulation of the blood and other writings*. London: Everyman.
- Hess, D. J. (1995). *Science and technology in a multicultural world: the cultural politics of facts and artifacts*. New York: Columbia University Press.
- Holton, G. J. (1996). *Einstein, history, and other passions: the rebellion against science at the end of the twentieth century*. Reading, MA: Addison-Wesley Publishing Company.
- Holton, G. (1993). *Science and anti-science*. Cambridge and London: Harvard University Press.
- Holton, G. (1978). *The scientific imagination*. Cambridge: Cambridge University Press.
- Holton, G. (1988). *Thematic origins of scientific thought*. Cambridge: Harvard University Press.
- Horgan, J. (1996). *The end of science*. Reading, MA: Helix Books.
- Horwich, P. (Ed.). (1993). *World changes: Thomas Kuhn and the nature of science*. Cambridge: MIT Press.
- Huff, T.E. (1995). *The rise of early modern science*. Cambridge: Cambridge University Press.
- Kauffman, S. A. (1993). *The origins of order*. New York: Oxford University Press.
- Kaufmann, T. D. (1993). *The mastery of nature: aspects of art, science, and humanism in the Renaissance*. Princeton: Princeton University Press.
- Keller, E. F. (1983). *A feeling for the organism*. New York: W.H. Freeman and Company.

Kevles, B. H. (1997). *Naked to the bone: medical imaging in the twentieth century*. New Brunswick, New Jersey: Rutgers University Press.

Kline, M. (1985). *Mathematics and the search for knowledge*. Oxford: Oxford University Press.

Kuhn, T. S. (1970). *The structure of scientific revolutions*. Chicago and London: University of Chicago Press.

Kotulak, R. (1996). *Inside the brain: revolutionary discoveries of how the mind works*. Kansas City, MO: Andrews McMeel Publishing.

Lakatos, I., & Musgrave, A. (Eds.). (1970). *Criticism and the growth of knowledge*. New York: Cambridge University Press.

Lewontin, R. C. (1992). *Biology as ideology: the doctrine of DNA*. New York: HarperCollins.

Lindberg, D. C. (1992). *The beginnings of Western science: the European scientific tradition in philosophical, religious, and institutional context*. Chicago: The University of Chicago Press.

McGrayne, S. B. (1993). *Nobel Prize women in science: their lives, struggles, and momentous discoveries*. New York: Carol Publishing Group.

McLeish, J. (1991). *The story of numbers: how mathematics has shaped civilization*. New York: Fawcett Columbine.

Miller, A. I. (1996). *Insights of genius: imagery and creativity in science and art*. New York: Springer-Verlag.

Montgomery, S. L. (1996). *The scientific voice*. New York and London: The Guilford Press.

Needham, J. (1953). *Science and civilisation in China*. Cambridge: Cambridge University Press. (8 vols)

Osserman, R. (1995). *Poetry of the universe: a mathematical exploration of the cosmos*. New York: Anchor.

Poincaré, H. (1952). *Science and hypothesis*. New York: Dover Publications, Inc.

Sarton, G. (1959). *A history of science*. Cambridge: Harvard University Press. (3 vols)

Scott, A. (1995). *Stairway to the mind: the controversial new science of consciousness*. New York: Springer-Verlag.

Snow, C. P. (1963). *The two cultures and the scientific revolution*. New York: Cambridge University Press.

- Snow, C. P. (1964). *The two cultures and a second look*. Cambridge: Cambridge University Press.
- Stewart, I. (1989). *Does God play dice?: the mathematics of chaos*. Cambridge: Penguin Books.
- Stewart, I. (1995). *Nature's numbers: the unreal reality of mathematics*. New York: BasicBooks.
- Stewart, I., & Golubitsky, M. (1992). *Fearful symmetry: is God a Geometer?* Oxford and Cambridge: Blackwell.
- Stigler, S. M. (1986). *The history of statistics: the measurement of uncertainty before 190*. Cambridge, Massachusetts: The Belknap Press of Harvard University Press.
- Suppe, F. (1977). *The structure of scientific theories*. Urbana and Chicago: University of Illinois Press.
- Swade, D. (1991). *Charles Babbage and his calculating engines*. London: The Science Museum.
- Trefil, J., & Hazen, R. M. (1995). *The sciences : an integrated approach*. New York: John Wiley & Sons, Inc.
- Van Sertima, I. (Ed.). (1983). *Blacks in science*. New Brunswick: Transaction.
- Watson, J. D. (1968). *The double helix*. New York: Atheneum.
- Wertheim, M. (1995). *Pythagoras' trousers*. New York: Random House.
- Westfall, R. S. (1990). *The construction of modern science: mechanisms and mechanics*. Cambridge: Cambridge University Press.
- Whitehead, A. N. (1953). *Science and the modern world*. New York: Free Press.
- Wilson, C. (1995). *The invisible world: early modern philosophy and the invention of the microscope*. Princeton: Princeton University Press.
- Wolpert, L. (1994). *The unnatural nature of science*. Cambridge, MA: Harvard University Press.
- Wright, M. R. (1995). *Cosmology in antiquity*. London and New York: Routledge.
- Yngne, V. H. (1996). *From grammar to science: new foundations for general linguistics*. Amsterdam: John Benjamins Publishing Co.
- Zajonc, A. (1993). *Catching the light: the entwined history of light and mind*. New York: Oxford University Press.