

History of Science 128VD

**Nature, Energy, Industry:
A Cultural History of Physical Science**

Harvard University

Fall 2019

Tuesdays, 3:00pm-5:00pm

Science Center 252

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This seminar explores the cultural history of the physical sciences at key moments from the seventeenth through the nineteenth century. We will immerse ourselves in the cultural, social, and political concerns of diverse historical actors as we ask: How did the study of natural philosophy gradually morph into the disciplines we recognize today as physics, astronomy, chemistry, and the earth sciences? How did energy regimes transform across this period, and how were these transformations related to novel physical ideas? How did industrial development, new artistic expressions, and technological innovation emerge in tandem with the creations and practices of physical science?

Each week, we will closely read sources (primary, secondary, or both) that express the curiosity, discoveries, frustrations, and interconnected worlds of the natural philosophers, craftsmen, scientists, authors, artists, and other practitioners engaging the scientific and technological developments of their time. To aid in developing a historicist sensibility – to look at the past on its own terms and learn to think as past historical actors thought – every week you will post to the discussion board on the course website a **focused short response (of about 100-200 words) to the week's readings** – either as a new post or in response to another student's post (by providing another example, counter-example, observation, or supportive analysis to what was already posted). All responses and comments should be written in complete sentences (as paragraphs or bullet-points), must be polite, and should be constructive if critiquing other comments. In most weeks I will have provided some questions to help you contextualize and close-read the texts, but you are most welcome (and encouraged) to also post questions and responses on other aspects of the texts that puzzle or intrigue you.

On the first day of class, you will sign up to be **the “Synthesizer” for one week**: your role that week will be to read through the responses on the discussion board before class and prepare a **short (approximately 5-minute) in-class presentation** on some of the key highlights, questions, debates, and examples given by yourself and your peers. This will assist in jumpstarting discussion in class.

The main assignment for the course will be a **10-page to 15-page final paper** based on your own historical research. The topic may mesh closely with one of the case-studies, scientific disciplines, historical persons, or comparative themes that we read about and discuss in the course. Alternatively, you could research any topic related to the physical sciences in the 17th through 19th centuries, in any region of the world.

The paper will be primarily historical, but you are free to bring your own knowledge or methodologies from the sciences, philosophy, literature, art history, sociology, anthropology,

and so forth into your analysis in the paper. Carefully perusing this syllabus and the readings in future weeks will provide you with many possible subjects and questions to consider. The sooner you start brainstorming possible topics and arguments – and the sooner you discuss your ideas with me – the better in order to have a chance to refine your topic and questions, to find materials to strengthen your argument, and to have time to draft and revise your final paper.

By October, you are **required to meet with me at my office-hours** as you begin planning your final paper topic and argument. On **October 24 by 6pm, you will submit a thesis statement, draft outline, and bibliography** for the final paper, and I will provide you with further suggestions and feedback. In the week before Thanksgiving break, you will be **required to meet with me by appointment to discuss your progress** on your final paper research. The **final paper** will be due by **5pm on December 9**.

Course Assignments and Grading:

Class participation (attendance and discussion):	20%
Weekly online discussion (response essays) based on readings:	25%
Short in-class Presentation:	10%
Thesis, Outline, and Bibliography for final paper (Due October 24, at 6pm):	20%
Final Paper (Due December 9, at 5pm):	25%

Readings:

All readings are on the course website – please bring the readings to class.

Schedule and Readings

September 3: Introduction and Overview

- Overview the course topics, schedule, and expectations; participant introductions
- Brief introduction to Waywiser to search Collection of Historical Scientific Instruments, which you are encouraged to explore: <http://waywiser.fas.harvard.edu/collections>
- Presentation by history of science librarians about resources in library and online: Widener Fred (burchst@fas.harvard.edu) & Lamont Emily (emilybell@fas.harvard.edu)

Part I: 17th Century to Early 18th Century: The Baroque

September 10: Experience/Experiment: The Mathematization of Nature?

- Galileo Galilei, excerpts from *Dialogue Concerning the Two Chief World Systems: Ptolemaic and Copernican* (1632), translated and with revised notes by Stillman Drake (New York: The Modern Library, 2001; orig. 1953):
Pages 5-7 (“Preface: To the Discerning Reader”); selections from Day II: pp. 123-132 (reasoning from evidence versus authority), pp.132-144 (evidence of the earth’s daily rotation explained), pp. 144-155 (Aristotelian counter-arguments), pp. 161-171 (supportive evidence from falling objects and experiments)

- Alexandre Koyré, “Galileo and Plato,” *Journal of the History of Ideas* 4, 4 (1943): 400-428.
- Excerpt from “The Uses of Experience,” in Peter Dear, *Discipline & Experience: The Mathematical Way in the Scientific Revolution* (Chicago: University of Chicago Press, 1995), pp. 124-141.

September 17: Manufacturing, Arts, and Instruments of Knowledge

- Excerpts from “Chapter 4: Nature’s Drawing,” in Ofer Gal and Raz Chen-Morris, *Baroque Science* (Chicago: University of Chicago Press, 2013), pp. 145-160.
- “The Mechanical Clock, Its Makers and Users,” in Otto Mayr, *Authority, Liberty and Automatic Machinery in Early Modern Europe* (Baltimore: Johns Hopkins University Press, 1986), pp. 3-27.
- “Chapter 1: Baroque Modes and the Production of Knowledge,” in Ofer Gal and Raz Chen-Morris, eds., *Science in the Age of Baroque* (Dordrecht: Springer, 2013), pp. 1-9.
- “The Vatican’s astronomical paintings and the Institute of the Sciences of Bologna,” in Silvio A. Bedini, *Science and Instruments in Seventeenth-Century Italy* (Brookfield: Ashgate Variorum, 1994), pp. xiii-xxxiii, plus 8 pages of photographs of the paintings.

September 24: Instruments of Navigation and Other Worlds

- “Fontenelle and Huygens,” in Michael J. Crowe, ed., *The Extraterrestrial Life Debate, Antiquity to 1915: A Source Book* (Notre Dame: University of Notre Dame Press, 2008), pp. 72-108.
- Dava Sobel and William J.H. Andrewes, *The Illustrated Longitude* (London: Fourth Estate, 1998), pp. 92-135.

Part II: 18th-Century to Early-19th-Century: Revolutions

October 1: The French Enlightenment, Revolution, and Napoleonic Science

- “Chapter IX: Application of the Calculus of Probabilities to Natural Philosophy,” in Marquis de Laplace, *A Philosophical Essay on Probabilities* (Paris, 1795; orig. pub. 1814), transl., Frederick William Truscott and Frederick Lincoln Emory (New York: Dover, 1951), pp. 73-106.
- Ken Alder, “The Measure of the World,” Dibner Library Lecture (Washington, DC: Smithsonian Institution Libraries, 2003).
- “Introduction,” in Theresa Levitt, *The Shadow of Enlightenment: Optical and Political Transparency in France 1789-1848* (Oxford: Oxford University Press, 2009), pp. 1-10.

October 8: The Industrial Revolution: Power, Time, and Work

- “Steam and Work,” in Bruce J. Hunt, *Pursuing Power and Light: Technology and Physics from James Watt to Albert Einstein* (Baltimore: Johns Hopkins University Press, 2010), pp. 4-24.
- Chapter 5 in Margaret Jacob, *Scientific Culture and the Making of the Industrial West* (Oxford: Oxford University Press, 1997), pp. 99-115.
- David Landes, *Revolution in Time: Clocks and the Making of the Modern World* (Revised and enlarged edition, Belknap Press, 2000, orig. 1983), pp. 231-247.

October 15: Revolutions in Geology and Optics: Deep History and Spectroscopy

- “Bursting the Limits of Time,” “Worlds Before Adam,” and “Disturbing a Consensus,” in Martin J. S. Rudwick, *Earth’s Deep History: How it was Discovered and Why it Matters* (Chicago: University of Chicago Press, 2014), pp. 103-180.
- “Introduction” and “Artisanal Knowledge and Achromatic Lenses,” in Myles W. Jackson, *Spectrum of Belief: Joseph von Fraunhofer and the Craft of Precision Optics* (Cambridge: MIT Press, 2000), pp. 1-15 and 43-84.

Thursday, October 24, at 6:00pm – Preliminary Thesis Statement, Outline, and Bibliography for your final paper Due

Part III: 19th-Century: Accelerating Transformations

October 22: Thermodynamics, Energy, and Labor

- “On the Interaction of the Natural Forces (1854)” and “On the Conservation of Force (1862-63),” in Hermann von Helmholtz, *Science and Culture: Popular and Philosophical Essays* (Chicago: University of Chicago Press, 1995), pp. 18-45 and 96-126.
- “Energy and Entropy,” in Bruce J. Hunt, *Pursuing Power and Light* (2010), pp. 25-45.
- “Chapter 2 – Transcendental Materialism: The Primacy of *Arbeitskraft* (Labor Power),” in Anson Rabinbach, *The Human Motor: Energy, Fatigue, and the Origins of Modernity* (Berkeley: University of California Press, 1990), pp. 45-68.

October 29: Astronomy, Statistics, and the Personal Equation

- Edward S. Holden, “The Personal Equation,” *The Popular Science Monthly* 6 (February 1875), available at https://en.wikisource.org/w/index.php?title=Popular_Science_Monthly/Volume_6/February_1875/The_Personal_Equation&oldid=8852287.
- Simon Schaffer, “Astronomers Mark Time: Discipline and the Personal Equation,” *Science in Context* 2, 1 (1988): 115-145.
- “Introduction,” in Theodore M. Porter, *The Rise of Statistical Thinking, 1820-1900* (Princeton: Princeton University Press, 1986), pp. 3-13.
- “Introduction” and “Chapter 1: Astronomy, Optics, and Point of View,” in Anna Henchman, *The Starry Sky Within: Astronomy and the Reach of the Mind in Victorian Literature* (Oxford: Oxford University Press, 2014), pp. 1-47.

November 5: On Light, Molecules, Saturn’s Rings, and Electromagnetism

- James Clerk Maxwell, “Molecules,” *Nature* (September 1873), available at <http://www.victorianweb.org/science/maxwell/molecules.html>.
- “Chapter III: Edinburgh physics and Cambridge mathematics,” in Peter M. Harmon, *The Natural Philosophy of James Clerk Maxwell* (Cambridge: Cambridge University Press, 1998), pp. 37-70.

Part IV: Late-19th-Century: Modernization

November 12: Electrification, Telegraphy, Empire

- “Chapter XI: All By Electricity,” in Jules Verne, *Twenty Thousand Leagues Under the Sea* (1870), available at <https://www.gutenberg.org/files/164/164-h/164-h.htm#chap11>.
- David E. Nye, *American Illuminations: Urban Lighting, 1800-1920* (Cambridge: MIT Press, 2018), pp. 11-83.
- Bruce J. Hunt, “Doing Science in a Global Empire: Cable Telegraphy and Electrical Physics in Victorian Britain,” in Bernard Lightman, ed., *Victorian Science in Context* (Chicago: University of Chicago Press, 1997), pp. 312-333.

November 19: Physics, Chemistry, Industry, and Pure Research

- “Theory and Practice in Organic Chemistry: Biological Modes of Thought in a Physical Science,” in Mary Jo Nye, *Before Big Science: The Pursuit of Modern Chemistry and Physics, 1800-1940* (Cambridge: Harvard University Press, 1996), pp. 120-146.
- “Chapter III: The Flaws of American Physics,” Daniel J. Kevles, *The Physicists: The History of a Scientific Community in Modern America* (Cambridge: Harvard University Press, 1987), pp. 25-44.

N.B. Will send email for scheduling to meet with me about your final paper before Thanksgiving Break.

November 26: NO CLASS TODAY – DISCUSS FINAL PAPER

Happy Thanksgiving!

December 3: Precision Experiments: Speed of Light and Electrons

- Isobel Falconer, “Corpuscles to Electrons,” in Jed Z. Buchwald and Andrew Warwick, eds., *Histories of the Electron: The Birth of Microphysics* (Cambridge: MIT Press, 2001), pp. 77-100.
- “Chapter 2: Albert Michelson, Velocity of Light, and Ether Drift,” in Richard Staley, *Einstein’s Generation: The Origins of the Relativity Revolution* (Chicago: University of Chicago Press, 2008), pp 27-64.

READING PERIOD: December 4-9

Monday, December 9, at 5:00pm – Final Paper Due