Science and Technology in the Twentieth Century

History 3C, Fall 2007
MW 2PM-3:15PM, Fowler A103B

Professor Soraya De Chadarevian	Professor Ted Porter
Office 5272 Bunche Hall	5262 Bunche Hall
Office hours: W 3:30-5	T 1-2, W 3:30-5
Phone: 310-267-4767 or 825-3888	310-206-2352
Email: chadarevian@history.ucla.edu	tporter@history.ucla.edu

Teaching assistants: Aimee Dowl, Adam Lawrence, Michael Weismeyer

Course description

What does it mean when the twentieth century is defined as the atomic age or the century of the gene? This course offers an introduction to major developments in the physical and life sciences as well as engineering, while demonstrating how the sciences and technologies develop in close interaction with other cultural, political, and economic endeavors. At the end of the nineteenth century, and then again during World War II, the sciences began to be supported and practiced on a new scale, which is evident in their laboratory findings and theoretical achievements as well as in their relations to industry and the state. We will review the role of the sciences in relation to the world wars and the Cold War, and to various political and social movements; changing attitudes to science by state, industry, and the public; evolving patterns of science funding and of styles and scales of research; the development of new techniques and instruments and the formation of new disciplines. Throughout, natural science developed in close connection with social and philosophical understandings. Students in this course should develop the critical tools and perspectives necessary to understand the place of the sciences and technology in modern society.

Books for purchase (At ASUCLA bookstore, Ackerman)

Diane Paul, *Controlling Human Heredity* (Humanities Press 1995)
Lawrence Badash, *Scientists and the Development of Nuclear Weapons* (Humanity Books 1998)
Michael Frayn, *Copenhagen* (Anchor Books 1998)
James Watson, *The Double Helix* (Norton Critcal Edition 1980)

Other readings will be made available at the course website and in a reader available for purchase.

Course requirements and grading

You are expected to do the reading and to attend lectures reliably. Section attendance is mandatory and absences will affect your section grade. You are requested to write six 1-page

written responses to the weekly readings for the section meetings in addition to the two short essays and the midterm paper.

Section participation and written responses to weekly readings : 30%
Take-home midterm (5-6 pages) 20%
two short essay assignments (3-4 pages each): 20% (total)
Final exam (short answers and essays): 30%

FILMS. As a supplement to the reading material we will make available for viewing in the AV room of Powell Library, and (if there is interest) show in optional afternoon or evening sessions, several relevant films, including: "Homo Sapiens 1900" (about eugenics); "Copenhagen" (filmed version of Frayn's play); "The Day After Trinity: J. Robert Oppenheimer and the Atomic Bomb," "The Race for the Double Helix," and "Kinsey."

Week 1: Science and Society, 1900 to 1920 [TP]
Lecture 1 [PDF]
Lecture 2 [PDF]
1 Science and the force of reason (Oct 1)
The achievements of science in the early twentieth century, among them relativity, quantized energy, physical chemistry, and genetics, reflect its heightened institutional power and its ties with technology. In this lecture we focus on the ambition to turn science into a new basis for social action, for culture and morality, to make the world more rational. The new field of statistics was conceived in this spirit.

2. The mobilization of science in World War I (Oct 3)
The Great War, which began with an outbreak of euphoria, soon placed demands on bureaucracy and planning that opened a major role for science, especially chemistry. The use of poison gas has by now a very bad odor, but many scientists were proud of their war work. In the end, as we will see, science was swept up by forces of nationalism that challenged its universalistic claims.

Karl Pearson, *The Grammar of Science* (first ed. 1892; 3rd ed. reprint 1937) chap. 1, 7-37
Manifesto of the 93 German intellectuals: "To the Cultured World"
http://net.lib.byu.edu/~rdh7/wwi/1914/93intell.html

Additional
Jeffrey Johnson, *The Kaiser's Chemists* (1990), chapter 9, 180-199
Theodore Porter, *Karl Pearson: The Scientific Life in a Statistical Age* (1995), chap. 7

Week 2: Genetics and the uses of heredity [SdC]
3. The making of genetics (Oct 8) Lecture 4 [PDF]
The terms "genes" and "genetics" were coined in the early twentieth century. In this lecture we will investigate the making of genetics as a discipline, taking into account the political and social nature of that development. We will study the role of the fruit fly in the establishment of

Mendelian genetics, and the debates of Mendelians with other geneticists in their struggle for authority in the field of heredity.

4. The eugenics movement (Oct 10) Lecture 5 [PDF]
Eugenics was a reform movement that found broad support in many countries. In this lecture we focus on the involvement of geneticists in eugenics. We also ask how heredity became an overriding concern in the early twentieth century.

Diane Paul, *Controlling Human Heredity*, chapters 1 and 3-6, pp. 1-21 and 40-114.
Social biology and population improvement ('The Geneticists' Manifesto'), *Nature*, 44 (1939), 521-522.

Additional:
Jan Sapp, "The Struggle for authority in the field of heredity, 1900-1932: new perspectives on the rise of genetics," *Journal of the History of Biology*, 16 (1983), 311-342
Robert Kohler, *Lords of the Fly* (1994), chapter 1, pp. 1-15 and chapter 3, pp. 53-90

Week 3: Science between the World Wars: technology and ideology [TP]
Lecture 3 [PDF]
5. Engineering the Russian Revolution (Oct 15)
The Russian Revolution, which rose up from the ruins of the Great War, initiated an effort to make a whole new society. We show how Lenin's utopian vision drew from a celebration of technology and from an American celebration of engineering and "scientific management," and how this grew into a distinctive program to remake science as a resource of socialism triumphant.

6. Radioactivity and the rise of nuclear physics (Oct 17)
Lecture 6 [PDF]
In this lecture we follow the development of nuclear physics from the discovery of radioactivity in the 1890s to the first splitting of the atom in 1938, by which time a new world war was looming.

Loren Graham, *Science in Russia and the Soviet Union* (1993), chap. 4, 79-98.
Kendall E. Bailes, "Alexei Gastev and the Soviet Controversy over Taylorism," *Soviet Studies*, 29 (1977), 373-394
Yevgeny Zamiatin, *We* (1921), 1-35
Thorstein Veblen, *The Engineers and the Price System*, (first published as a series of magazine articles in 1919) chap. VI, "Memorandum on a Practicable Soviet of Technicians," 132-151.

Week 4: Science and Technology in World War II [SdC]
7. Preparing for World War II (Oct 22) Lecture 7 [PDF]
During World War II, scientists were mobilized on an unprecedented scale. We will study what scientists offered and how they justified their services to the war effort. Two products of the scientific mobilization effort attracted special attention after the war: penicillin and the bomb. In

this lecture we will focus on the penicillin project that led to the production of the miraculous drug in time for the landing in Normandy. We will especially investigate the new relations of government, medicine and industry the wartime project introduced.

8. The Manhattan Project (Oct 24) Lecture 8 [PDF]
World War II ended shortly after the dropping of atomic bombs on Hiroshima and Nagasaki. We will study the secret American wartime project that led to the production of the bombs and the logic that led to their use, with special attention to the role of scientists. We will also attempt to assess the postwar legacies of this momentous event.

Badash, *Scientists and the Development of Nuclear Weapons*, introduction and chapters 2-5, pp. 1-2 and 11-79

Additional
P. Neushul, "Science, government and the mass production of penicillin," *Journal of the History of Medicine and Allied Sciences*," 48 (1993), 371-395

Take-Home Midterm due: Monday, Oct. 29

Week 5: Science under National Socialism [SdC]
9. The place of science in Nazi Germany (Oct 29) Lecture 9 [PDF]
Science and technology played as important a role in Nazi Germany as in the allied countries. In this lecure we will study the organization of the Nazi state, its racial politics, and the implications of practices of human experimentation in the concentration camps for our understanding of science.

10. The German nuclear project and the V2 missiles (Oct 31) Lecture 10 [PDF]
The German nuclear project has been the subject of much debate. We will look at various interpretations and try to understand why the issue continues to be so contentious. We will also study the Nazi missile project and its legacies in the Cold War US and Soviet space programs.

Frayn, *Copenhagen* (including the postscript; we also encourage you to watch the video of the performance; a viewing will be organized)

Additional:
Mario Biagioli, "Science, modernity, and the 'final solution'" in *Probing the Limits of Representation*, ed. S. Friedlaender (1992), 185-205.
Mark Walker, "Legends surrounding the German atomic bomb," in *Science, Medicine and Cultural Imperialism*, ed. T. Meade and M. Walker (1991), 178-204.

Week 6: The Postwar Organization of Science [TP]
11. Ideals of research: mission-oriented science vs. free inquiry (Nov 5) Lecture 11 PDF
In the 1930s, the Soviet mobilization of research for very practical problems was much admired, and the Manhattan project seemed in a way to vindicate this form of science. But the National

Science Foundation was set up on a different model, which relied on the community of science to define important problems. We will examine writings by J. D. Bernal, Michael Polanyi, and Vannevar Bush in which these issues were debated.

12. Physicists and the military-industrial-academic complex (Nov 7) Lecture 12
And yet, science in general and physics in particular were seen during the Cold War as indispensable for national security, and American physics expanded hugely, and was linked by funding and sometimes by research problems to military objectives. We will examine the reshaping of physics in this Cold War context.

J. D. Bernal, *The Social Function of Science* (1939), chap. XVI, 135-143.
Michael Polanyi, *Knowing and Being* (1958), chap 4, "The Republic of Science: Its Political and Economic Theory" (1962), 49-71, and chap. 5, "The Growth of Science in Society (1967), 72-86
Vannevar Bush, *Science, the Endless Frontier* (1945, 35 pp.)

Additional
David Hollinger, *Science, Jews, and Secular Culture* (1998), chap. 5, "The Defense of Democracy and Robert K. Merton's Formulation of the Scientific Ethos," 80-96
Daniel J. Kevles, *The Physicists* (1971), chap. 22, "Victory for Elitism," 349-366.

Essay on Frayn's *Copenhagen* due: Weds., Nov. 14.

Week 7: Social Sciences and the Postwar State [TP] Lecture 13
13. The social sciences in war and peace (Nov 14)
The ideal of "science" in social science has had various meanings, and in the twentieth century it has meant an uneasy fusion of efforts to manage the economy and society with an ideal of free research. We will study the ways that social science modeling and statistics have exemplified these somewhat contradictory ambitions.

Hunter Crowther-Heyck, "Patrons of the Revolution," *Isis*, 97 (2006), 420-446
Sarah Igo, *The Averaged American* (2007), chaps. 5-6, pp. 191-280

Additional
Mary Morgan, "Economics" in Theodore M. Porter and Dorothy Ross, eds., *Cambridge History of Science, vol. VII: Modern Social Sciences* (2003), 275-305

Week 8: The Postwar Transformation of Biology [SdC] Lecture 14 PDF
14. The double helix in perspective (Nov 19)
In the history of postwar biology the DNA double helix looms large. We will situate it in the broader context of biological research at the time and try to understand how it has become a dominant icon of twentieth-century science.

15. Biology in the nuclear age (Nov 21) [viewed film. no lecture]

This lecture continues the discussion of the preceding one by taking a broader look at the postwar transformation of biology. We will focus on postwar funding policies, the opportunities for biological research created by the nuclear age and the rise of biomedicine.

James Watson, *The Double Helix* (original text; we also encourage you to look at the other perspectives on the story and the reviews, and to view the film "The Race for the Double Helix")
Erwin Chargaff, "A quick climb up Mount Olympus," [review of The Double Helix] *Science* 159 (1968), 1448-9
Soraya de Chadarevian, "Portrait of a discovery," *Isis* 94 (2003), 95–105

Additional:
John Beatty, "Genetics in the Atomic Age", in *The Expansion of American Biology*, ed. K.B. Benson, J. Maienschein and R. Rainger (Rutgers 1991), pp. 284-324
Francis Crick, "What Mad Pursuit: A Personal View of Scientific Discovery", (Penguin Books 1989), 80-88
Sarah Brooks Franklin, "Life Story: The Gene as Fetish Object on TV," in Science as Culture, (1988) 92-100

Week 9: The 1960s: Environmentalism and the Changing Role of Science [TP] Lecture 16 PDF
16. Vietnam and the critique of scientism (Nov 26)
Robert McNamara's reliance on cost-benefit quantification and body counts to fight the Vietnam War typified for 1960s radicals the corruption of science. We will examine the critique of science as a tool of power and a means of domination, and the growth of new forms of science allied to environmentalism and public health.

17. Environmentalism, modeling, and global climate change (Nov 28) Lecture 17 PDF
The study of climate change exemplifies a new form of science, associated with the vast expansion of computing power. We will examine the history of modeling as a strategy for understanding complexity and for predicting the future.

The Limits to Growth [Report of the Club of Rome] (1972), 9-24, 88-128
Theodore Roszak, "Science: A Technocratic Trap," *The Atlantic*, 230 (July 1972), 56-61

Additional
David Halberstam, *The Best and the Brightest* (1972), sections of Robert McNamara and the idealization of measurement)

Essay on Watson's *Double Helix* due: Monday 3 December

Week 10: Science and Commercialization [SdC and TP]
18. Rise of the biotech industry (Dec 3) Lecture 18 PDF

We will start by speaking about the moratorium proposed by scientists in 1974 to work on recombinant DNA and the ensuing public debate. We will then look at the rapid dismantling of the guidelines drawn up for work with the new technologies in the context of the rise of the biotech industry. We will also discuss the Human Genome Project as a post-Cold War project.

Paul Berg et al. "Potential biohazards of recombinant DNA molecules" ('Berg Letter'), *Science* 185 (1974), 303
Martin Kenney, "Biotechnology and the creation of a new economic space," in *Private Science,* ed. A. Thackray (1998), pp. 131-143.

Additional:
John Beatty, "Origins of the US Human Genome Project", in *Controlling Our Destinies,* ed. P. Sloan (University of Notre Dame Press 2000), 131-153

19. Public Science: Outlook (Dec 5)
In this final lecture we will discuss where science stands at the beginning of the 21st century.

Final Exam, Friday, December 14, 11:30-2:30.