IGA 205
SCIENCE, TECHNOLOGY, AND INNOVATION AND PUBLIC POLICY

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SYLLABUS

Class meets T-Th from 1:10-2:30 in Land Lecture Hall, Belfer Building 4th Floor

Professor Narayanamurti's office hours will be Tuesdays and Thursdays 11AM-12 PM in L370. Professor Bunn's office hours will be Tuesdays and Thursdays 2:30-4PM in L339C. To make an appointment to see Professor Narayanamurti, please contact Karin Vander Schaaf (karin_vander_schaaf@hks.harvard.edu, 6-5584). To make an appointment to see Professor Bunn, please put your name on the sign-up sheet on his door and call or e-mail his faculty assistant, Lillian Politser (lillian_politser@harvard.edu, 6-0817) indicating the topic you would like to discuss.

Overview

From the digital revolution to biotechnology, from climate change to coping with emerging diseases, from intellectual property rights to new weapons and sensors for the modern battlefield, science and technology are critical factors in a wide range of public policies – and public policy plays a major role in shaping progress in science and technology. Effective policies must maximize the benefits of science and technology while minimizing the risks, to promote economic growth, environmental sustainability, and international security. In this course, students learn the institutional landscape, the processes by which science and technology policies are made, and key methodologies for doing public policy analysis related to science, technology, and innovation. Along the way, students will examine some of the most challenging and interesting science and technology-related public-policy issues of the 21st century with several classes being devoted to current issues or case studies. For each of these cases, students learn the foundations of technological literacy essential to informed policy choices. The course's coverage is global (though with a heavier focus on the United States), and includes not only government policy but also the interactions among government, business, academic institutions, and other interested non-government organizations.

Students will also be encouraged to hone their writing, reading, speaking, and analysis skills through the assignments. This course is open to graduate students from any school or department, and to qualified undergraduates with the permission of the instructors; the diversity of backgrounds enriches the course. No previous technical background is required.

Assignments and Grading

There are six assignments for this course. The first assignment is an op-ed, similar to those that appear in U.S. daily newspapers, in which students will choose a particular area of science and technology policy about which to make a recommendation. The next three assignments will focus on particular science and technology policy issues: students will be divided into groups, and for each of the three, some of the groups will make presentations which will be discussed in class, while the remaining students will write short policy memos. The groups making presentations will rotate, so that during the course of the

semester, each student will participate in at least one group presentation to the class. The fifth assignment will be participation in a simulation relating to the role of science and technology in climate-change policy. Each student will receive a slightly different assignment for the simulation. Detailed instructions will be given the week before the simulation. The simulation week is likely to involve more work outside of class than usual, and each student will be expected to write a short reflection on the simulation after it is over. The sixth assignment is a final exam, which is a take-home exam exploring several key science and technology policy issues.

Assignments must be posted to the class page by 5:00 PM on the day they are due. Late assignments will be marked down one grade for each day they are late, unless the instructors grant an exception due to special circumstances. The assignments will be due on the following dates:

Op-ed: 9/18

Policy memo/presentation 1: 10/6

Policy memo/presentation 2: 10/22

Simulation reflection: 11/2

Policy memo/presentation 3: 11/17

Final Exam: distributed 12/3, due 12/10

Grading for this course is as follows:

Op-ed: 10%

Policy memos/presentations: 10% each (total of 30%)

Simulation: 15%

Class participation: 20%

Final exam: 25%

Expectations

The Kennedy School is a professional school, training professionals. As such, students are expected to: attend all classes; be on time; submit assignments on time; be respectful of each other and of the instructor; and do their best to prepare professional products for their assignments. Students are expected to have read the required readings *before* class – many of the classes will be discussions of issues raised in the readings. Recommended readings represent additional resources that may be useful for students particularly interested in a particular topic, but reading them is *not* required.

The importance of class participation. This class emphasizes discussion. Science and technology policies are often set in discussions among groups of officials representing different agencies; the ability to participate in such discussions cogently and effectively is a key skill for careers in science and technology policy. Hence, students should be aware that a significant portion of the total grade will be based on participation in class. Students are *only* permitted to have computers in class for the purpose of taking notes; having a laptop open will greatly increase a student's chance of getting a sudden question from one of the professors, and any student who clearly has not been paying attention to the class's discussion will see his or her class participation grade reduced. Students may not use smartphones or similar devices in class.

An important reminder about citing sources. Students *must* be familiar with and observe Kennedy School and Harvard rules regarding the citation of sources. Any sentences or paragraphs taken verbatim from the writing of (or interviews with) any other person or persons, or from your own writing

that has been published elsewhere, must be placed in quotation marks and their source must be identified with a footnote or endnote that includes the usual bibliographic information: author's name, title of article or chapter, venue (book, journal, magazine, website, report, thesis, term paper, private letter), date, and page numbers if applicable. (Note: A URL with no title, author, or date is *not* a complete reference; if in doubt, check the *Chicago Manual of Style* or similar style guides.) Changing the wording of a sentence or passage slightly does not evade the requirement for citation (nor reduce the chance of detection). Indeed, whenever you are drawing an important argument or insight from someone else, even if you reword it into your own words, a reference to the source is required. All of these requirements also apply to material taken from websites. Including material from others in assignments, exams, or term papers without appropriate quotation marks and citations is regarded, as a matter of School and University policy, as a serious violation of academic and professional standards and can lead to a failing grade in the course, failure to graduate, and even expulsion from the University.

Class schedule

Class	Date	Topic	Speaker
1	9/3	Why "science, technology, and public policy" matters	VN+MB
2	9/8	The knowledge-based economy: the role of innovation in economic growth, environmental sustainability, and international security	VN
3	9/10	Policy mechanisms Regulation (induced innovation?), funding, tax incentives, procurement, education and training	MB
4	9/15	Federal support for R&D – beyond the basic-applied dichotomy	VN
5	9/17	Institutions for innovation: universities, national and corporate laboratories, and more	VN
6	9/22	Issue: How should the new ARPA-E be structured?	VN
7	9/24	Issue: Promotion and regulation of nanotechnology	VN
8	9/29	S&T policymaking institutions (executive, legislative, courts)	MB
9	**10/1**	Sources of S&T advice and analysis (interest groups, NGOs, private sector, science advisory bodies, universities, individuals)	MB
10	**10/6**	Issue: Promotion and regulation of nanotechnology	Students,VN
11	10/8	Risk assessment and cost-benefit analysis in regulation	MB
12	10/13	Intellectual property rights – driving or constraining innovation?	Scherer
13	**10/15**	Strengths and weaknesses of models: response to climate	MB
14	10/20	Issue: Policies for stem cell research	Lensch
15	**10/22**	Risk assessment, science, and political interests: fine particulates	Students, MB
16	10/27	Simulation: Negotiating climate and low-carbon energy legislation	Students, MB
17	10/29	Simulation: Negotiating climate and low-carbon energy legislation	Students, MB
18	11/3	Issue: Cybersecurity	Waldo, VN
19	11/5	Issue: The nuclear energy revival and the risk of nuclear proliferation	MB
20	11/10	Strengthening S&T education, sustaining a competitive S&T workforce	VN
21	11/12	Science and technology for development	Juma
22	11/17	Issue: The nuclear energy revival and the risk of nuclear proliferation	Students, MB
23	11/19	S&T in democracy	Jasanoff
24	11/24	International science, technology, and innovation policies	MB
	11/26	HOLIDAY: THANKSGIVING	
25	12/1	Globalization of science and technology	VN
26	12/3	What have we learned? And careers in S&T policy	VN+MB

IGA-205 READING and HOMEWORK

There is no textbook for this course. Most of the course readings are available on the internet. Those that are not will be available in a packet from the Course Materials Office. Links are provided below to material available on the internet. Links to that material will also be available on the course page.

1 9/3 Why science, technology, innovation, and public policy matters

Barack Obama, address to the National Academy of Sciences, 27 April 2009.
http://www.whitehouse.gov/the_press_office/Remarks-by-the-President-at-the-National-Academy-of-Sciences-Annual-Meeting/

John P. Holdren, "Science and Technology for Sustainable Human Well-Being," *Science,* 25 January 2008, Vol. 319, pp. 424-434.
http://www.sciencemag.org/cgi/content/full/319/5862/424

Vannevar Bush, *Science: The Endless Frontier* (Washington, D.C.: U.S. Government Printing Office, 1945), "Summary of the Report," "Introduction," and "Science and the Public Welfare," and "The Means to the End."
http://www.nsf.gov/od/lpa/nsf50/vbush1945.htm

"Interview with Martin Rees" (concerning his book *Our Final Hour*), *La Stampa,* 23 February 2005
http://www.stefaniamaurizi.it/Interviste/en-martin_rees.html

Suggested:

Joseph E. Stiglitz, "Evaluating Economic Change," *Daedalus*, Summer 2004, pp 1-25.
http://www.mitpressjournals.org.ezp-prod1.hul.harvard.edu/doi/pdf/10.1162/0011526041504551

National Science Board, *Science and Engineering Indicators 2000*, Chapter 1, "Science and Technology in Times of Transition: the 1940s and 1990s," pp. 1-1 to 1-40.
http://www.nsf.gov/statistics/seind00/pdf/c1/c01.pdf

2 9/8 The knowedge-based economy: the role of innovation in economic growth, environmental sustainability, and international security

Committee on Prospering in the Global Economy of the 21st Century, Committee on Science, Engineering, and Public Policy, National Academy of Sciences, National Academy of Engineering, and the National Institute of Medicine *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, (Washington, DC: National Academy Press, 2006). *Read summary, plus one chapter of your choice.*
http://www.nap.edu/catalog.php?record_id=11463

Roger Pielke, "Hoodwinked!" 3/14/06 and "What U.S. Competitiveness Crisis?" 7/7/08 (blog posts responding to issues raised in *Rising Above the Gathering Storm*)
http://sciencepolicy.colorado.edu/prometheus/archives/gathering_storm/index.html#000744
http://sciencepolicy.colorado.edu/prometheus/archives/science_policy_general/index.html#001472

UN Development Programme, "Making New Technologies Work for Human Development," Overview from *Human Development Report 2001*, pp 1-8.
http://hdr.undp.org/en/reports/global/hdr2001/

National Science Board, *Science and Engineering Indicators 2008*, "Overview".
http://www.nsf.gov/statistics/seind08/

Suggested:

Joseph Schumpeter, *The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle* (Cambridge, MA: Harvard, 1934 [1st German edition 1912]), pp. 57-66.

Robert Solow, "Technical Change and the Aggregate Production Function," *Review of Economics and Statistics*, Vol. 39, No. 3 (1957), pp. 312-320. http://www.jstor.org.ezp-prod1.hul.harvard.edu/stable/pdfplus/1926047.pdf

Kenneth Arrow, "Classificatory Notes on the Production and Transmission of Technological Knowledge," *American Economic Review*, Vol. 59, No. 2 (1969), pp. 29-35.http://ezp-prod1.hul.harvard.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=4489927&site=ehost-live&scope=site

3 9/10 Policy mechanisms

Regulation ("induced innovation"), funding, tax incentives, procurement, education and training

Congressional Budget Office, *Federal Support for Research and Development* (Washington, D.C.: CBO, June 2007), 28 pp.
http://www.cbo.gov/doc.cfm?index=8221&type=1

Lewis M. Branscomb and James H. Keller, "Towards a Research and Innovation Policy," in Lewis M. Branscomb and James H. Keller, eds., *Investing in Innovation* (Cambridge, Mass.: MIT Press, 1999), pp. 462-496.

Timothy Lee, "Ars Book Review: 'Patent Failure'" *Ars Tecnica*, 15 July 2008 (Review of James Bessen and Michael Meurer, *Patent Failure: How Judges, Bureaucrats, and Lawyers Put Innovators at Risk*)
http://arstechnica.com/old/content/2008/07/book-review-7-08.ars

Suggested:

Committee on Prospering in the Global Economy of the 21st Century, Committee on Science, Engineering, and Public Policy, National Academy of Sciences, National Academy of Engineering, and the National Institute of Medicine *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, (Washington, DC: National Academy Press, 2006), "How is America Doing Now in Science and Technology?" pp. 68-106; "What Actions Should America Take in K-12 Science and Mathematics Education to Remain Prosperous in the 21st Century?" pp. 112-135; "What Actions Should America Take in Science and Engineering Research to Remain Prosperous in the 21st Century?" pp. 136-161; "What Actions Should America Take in Science and Engineering Higher Education to Remain Prosperous in the 21st Century?" pp. 162-181; and "What Actions Should America Take in Economic and Technology Policy to Remain Prosperous in the 21st Century?" pp. 182-203; http://www.nap.edu/catalog.php?record_id=11463

Leon Clarke, John Weyant, and Alicia Birky, "On the Sources of Technological Change: Assessing the Evidence," *Energy Economics*, Vol. 28, 2006, pp. 579-595. http://ezp-prod1.hul.harvard.edu/login?url=http://dx.doi.org/10.1016/j.eneco.2006.05.004?nosfx=

Michael E. Porter and Claas van der Linde, "Toward a New Conception of the Environment-Competitiveness Relationship," *Journal of Economic Perspectives*, Vol. 9, No. 4, Fall 1995, pp. 97-118.
http://www.greengrowth.org/download/green-business-pub/Greening_of_the_Business/Additional_E_resources/Greening_Business/Porter.pdf

Robert Hunt and Brian Kahin, "Reexamining the Patent System," *Issues in Science and Technology*, Fall 2008, http://www.issues.org/25.1/p_hunt.html

4 9/15 Federal support for R&D – beyond the basic-applied dichotomy

American Association for the Advancement of Science, "Guide to R&D Funding Data – Online Tutorial on the Federal Budget," 2008, http://www.aaas.org/spp/rd/budsem01.htm) (W) (complete 4-page tutorial);

Donald E. Stokes, *Pasteur's Quadrant: Basic Science and Technological Innovation*, (Washington, D.C.: Brookings Institute Press, 1997) "Stating the Problem (with notes)" pp. 1-25, 153-156, "Transforming the Paradigm (with notes)", pp. 58-89, 162-165, "Basic Science and American Democracy (with notes)", pp.111-152, 168-173.

Suggested:

Committee on Science, Engineering, and Public Policy (NAS/NAE/IOM), *Evaluating Federal Research Programs* (Washington, D.C.: National Academy Press, 1999), pp. 13-41. http://www.nap.edu/catalog.php?record_id=6416

5 9/17 Institutions for innovation

Lewis M. Branscomb and Richard Florida, "Challenges to Technology Policy in a Change World Economy," pp. 3-39; Lewis M. Branscomb, "From Science Policy to Research Policy," pp.112-139; and Harvey Brooks and Lucien P. Randazzese, "University-Industry Relations: The Next Four Years and Beyond," pp. 361-399 all in Lewis M. Branscomb and James E. Keller, eds., *Investing in Innovation* (Cambridge, Mass.: MIT Press, 1999).

Suggested:

Richard S. Rosenbloom and William J. Spencer, eds., *Engines of Innovation* (Cambridge, Mass.: Harvard Business School Press, 1996), pp. 13-85, 87-109, 111-129.

Richard R. Nelson and Richard R. Rosenberg, *National Innovation Systems: A Comparative Analysis* (New York: Oxford University Press, 1993), pp. 3-21.

6 9/22 Issue: Motivations for establishing an ARPA-E

Laura Diaz Anadon and John P. Holdren , "Policy for Energy Technology Innovation," in Kelly Sims Gallagher, ed., *Acting in Time on Energy Policy* (Washington, D.C.: Brookings, 2009), pp. 89-127.

U.S. Department of Energy, *"Recovery Act" Financial Assistance and Funding Opportunity Announcement: Advanced Research Projects Agency – Energy (ARPA-E),* Funding Opportunity Number DE-FOA-0000065 (Washington, D.C.: April 27, 2009).
http://arpa-e.energy.gov/keydocs/ARPA-E-FOA.PDF

Jane R. "Xan" Alexander, *An Energy Future Transformed: The Advanced Research Projects Agency – Energy (ARPA-E) –R&D Pathways to a Low-Carbon Future* (Washington, DC: Clean Air-Cool Planet, July 2009), pp. 4-13 (Executive Summary), pp. 77-80 (end of Chapter 8, Chapter 9), and pp. 96-100 (ARPA-E pages of the America COMPETES Act).
http://www.cleanair-coolplanet.org/cpc/documents/ARPA-E_AnEnergyFutureTransformed.pdf

7 9/24 Issue: Promotion and regulation of nanotechnology

Kenneth W. Abbott, Gary E. Marchant, and Douglas J. Sylvester, "A Framework Convention for Nanotechnology," *Environmental Law Reporter*, Vol. 36, 2006, pp. 10931-10942
http://cns.asu.edu/cns-library/title/?action=getfile&file=1&section=lib

Daniel Barben, Erik Fisher, Cynthia Selin and David H. Guston. "Anticipatory Governance of Nanotechnology: Foresight, Engagement, and Integration," in Edward J. Hackett, Olga Amsterdamska, Michael Lynch, and Judy Wajcman, eds., *The Handbook of Science and Technology Studies*, 3rd Ed. (Cambridge, MA: MIT Press, 2008), pp. 979-1000.
http://cns.asu.edu/cns-library/title/?action=getfile&file=103&section=lib

George Khushf, "The Ethics of Nanotechnology" in *Emerging Technologies and Ethical Issues in Engineering* (Washington, D.C.: National Academies Press: 2004), pp. 29-35.
http://www.nap.edu/catalog.php?record_id=11083

8 9/29 S&T Policymaking Institutions (executive, legislative, courts)

Handout: U.S. government science and technology agencies and decision-making bodies

David M. Hart, "Managing Technology Policy at the White House," in Lewis M. Branscomb and James H. Keller, eds., *Investing in Innovation* (Cambridge, Mass.: MIT Press, 1999), pp. 438-461.

Margeret A. Berger, "Expert Testimony: The Supreme Court Rules," *Issues in Science and Technology*, Summer 2000, pp. 57-63.
http://www.issues.org/16.4/berger.htm

Henry Kelly, Ivan Oelrich, Steven Aftergood, and Benn H. Tannenbaum, *Flying Blind: The Rise, Fall, and Possible Resurrection of Science Advice in the United States* (Washington, D.C.: Federation of American Scientists, 2004), Executive Summary and pp. 27-34, 38, 42-45, 51-56.
http://www.fas.org/resource/12022004142618.pdf

Suggested:

Jennifer Sue Bond, Mark Schaefer, David Rejeski, and Rodney W. Nichols, *OSTP 2.0: Critical Upgrade: Enhanced Capacity for White House Science and Technology Policymaking* (Washington, D.C.: Woodrow Wilson International Center, December 2008)
http://www.wilsoncenter.org/news/docs/OSTP%20Paper1.pdf

Sheila Jasanoff, *Science at the Bar: Law, Science, and Technology in America* (Cambridge, Mass.: Harvard University Press, 1995).

9 10/1 Sources of S&T advice and analysis (interest groups, NGOs, private sector, science advisory bodies, universities, individuals)

Frederick Anderson, "Improving Scientific Advice to Government," *Issues in Science and Technology*, Spring 2003
http://www.issues.org/19.3/p_anderson.htm

David Michaels and Celeste Monforton, "Manufacturing Uncertainty: Contested Science and the Protection of the Public's Health and Environment," *American Journal of Public Health*, Supplement 1, 2005, Vol. 95, No. S1, pp. S39-S48
http://defendingscience.org/upload/Michaels-Monforton.pdf

Frank von Hippel, "Peer Review of Public Policy," in Frank von Hippel, *Citizen Scientist* (Washington, D.C.: American Institute of Physics, 1991), pp. 16-29.

Suggested:

Sheila Jasanoff, *The Fifth Branch: Science Advisers as Policymakers* (Cambridge, Mass.: Harvard University Press, 1990)

Union of Concerned Scientists, "2004 Scientist Statement on Restoring Scientific Integrity to Federal Policy Making," 18 February 2004 http://www.ucsusa.org/scientific_integrity/abuses_of_science/scientists-sign-on-statement.html

Gerald L. Epstein, "Restart the Office of Technology Assessment," *Science Progress,* 31 March 2009, http://www.scienceprogress.org/2009/03/restart-ota/

Seth Shulman, *Undermining Science: Suppression and Distortion in the Bush Administration* (Berkeley, Calif: University of California Press, 2006), 232 pp.

Matthew Envangelista, *Unarmed Forces: The Transnational Movement to End the Cold War* (Ithaca, NY: Cornell, 2002), pp. 279-288. [Describes the role of non-government scientists from the Natural Resources Defense Council and elsewhere, working with Soviet scientists, in demonstrating seismic verification of a nuclear test ban over the objections of the Reagan administration.]

Harvey Brooks, "Issues in High-Level Science Advising," in William T. Golden, ed., *Science and Technology Advice to the President, Congress, and the Judiciary* (New Brunswick: Transaction, 2nd ed. 1995), pp. 51-64.

Carnegie Commission on Science, Technology, and Government, *Facing Toward Governments: NGOs and Scientific and Technical Advice* (New York: Carnegie Commission, 1993), pp. 13-51 http://www.carnegie.org/sub/pubs/science_tech/ngo.txt

10 10/6 Issue: Promotion and regulation of nanotechnology (student presentations)

11 10/8 Risk assessment and cost-benefit analysis in regulation

M. Granger Morgan, "Probing the Question of Technology-Induced Risk," and Paul Slovic, Baruch Fischhoff, and Sarah Lichtenstein, "Rating the Risks," in Theodore S. Glickman and Michael Gough, eds., *Readings in Risk* (Washington, DC: Resources for the Future, 1990), pp. 5-15 and 61-75.

John D. Graham, "Decision-Analytic Refinements of the Precautionary Principle," *Journal of Risk Research*, Vol. 4, No. 2, 2001, pp.127-141 http://ezp-prod1.hul.harvard.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=bth&AN=4859808&site=ehost-live&scope=site

J.P. Tomain, "Junk Economics" (Review of *Priceless: On Knowing The Price of Everything and The Value of Nothing*) *Georgetown Law Journal*, Vol. 92 (2004).

http://sciencepolicy.colorado.edu/about_us/meet_us/roger_pielke/envs_5120/week_5/Tomain.pdf

Steven Kelman, "Cost-Benefit Analysis: An Ethical Critique (With Replies)," *AEI Journal on Government and Society Regulation* (January/February 1981), pp. 33-40. http://classes.seattleu.edu/economics/econ468/green/Articles/Cost-benefit.pdf

Suggested:

Daniel Kammen and David Hassenzahl, *Should We Risk It?* (Princeton: Princeton University Press, 2001) Introduction and Chapter 8, "Technological Risk" pp. 265-303.

Committee on Risk Characterization, National Research Council, *Understanding Risk: Informing Decisions in a Democratic Society* (Washington, D.C.: National Academy Press, 1996), "Summary" and Chapter 1, "The Idea of Risk Characterization," pp. 1-36.

Frank Ackerman and Lisa Heinzerling, *Priceless: On Knowing the Price of Everything and the Value of Nothing* (New York: The New Press, 2004), pp. 1-12, 13-40, 41-60, 205-234.

W. Kip Viscusi and Joseph E. Aldy, "The Value of a Statistical Life: A Critical Review of Market Estimates throughout the World," NBER Working Paper No. W9487, February 2003. http://sciencepolicy.colorado.edu/about_us/meet_us/roger_pielke/envs_5120/week_5/Viscusi.pdf

12 10/13 Intellectual property rights – driving or constraining innovation?

F.M. Scherer, "The Political Economy of Patent Policy Reform in the United States," *Journal of Telecommunications and High-Technology Law*, Vol. 7, 2009, pp. 167-216. http://www.researchoninnovation.org/scherer/Scherer-PoliticalEconomy2009.pdf

Richard Levin, "A Patent System for the 21st Century," *Issues in Science and Technology*, Summer 2004, http://www.issues.org/20.4/levin.html

Yochai Benkler, "Commons-Based Strategies and the Problems of Patents," *Science*, Vol. 305, 20 August 2004, pp. 1110-1111. http://www.sciencemag.org.ezp-prod1.hul.harvard.edu/cgi/reprint/305/5687/1110.pdf

Ha-Joon Chang, "Intellectual Property Rights and Economic Development: Historical Lessons and Emerging Issues," in *Globalization, Economic Development, and the Role of the State*, (London: Zed Books, 2003), pp. 273-304

David Teece, "Reflections on Profiting from Innovation," *Research Policy*, Vol. 35, 2006, pp. 1131-1146, http://www.lu.se/upload/CIRCLE/INN005/Teece_Reflections.pdf

13 10/15 Strengths and weaknesses of models: response to climate

Intergovernmental Panel on Climate Change, "Summary for Policymakers" in *Climate Change 2007: Synthesis Report* (IPCC, November 2007)
http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr_spm.pdf

Handout (to be distributed in class): Strengths and Weaknesses of Modeling – and the Case of Integrated Assessment Models of Climate

A simple interactive climate model:
http://forio.com/simulation/climate-development/
http://climateinteractive.org

William D. Nordhaus, "Global Warming Economics," *Science*, Vol. 294, pp. 1283-1284 (9 November 2001).
http://nordhaus.econ.yale.edu/nordhaus_science_110901.pdf

Steve Fetter, *Climate Change and the Transformation of World Energy Supply* (Palo Alto: Center for International Security and Cooperation, Stanford University, 1999, pp. 14-16. http://iis-db.stanford.edu/pubs/10228/fetter.pdf (showing that both damages and mitigation costs are so uncertain that the optimal policy might be no action, immediate halt to the use of fossil fuels, or anything in between)

Carl Kaysen, "The Computer That Printed Out W.O.L.F." *Foreign Affairs,* July 1972. [Critique of the use of models in the "Limits to Growth" study.]
http://www.jstor.org.ezp-prod1.hul.harvard.edu/stable/pdfplus/20037939.pdf

Suggested:

Frank Ackerman, *Can We Afford the Future? The Economics of a Warming World* (London: Zed Books, 2009).

Orrin Pilkey and Linda Pilkey-Jarvis, *Useless Arithmetic: Why Environmental Scientists Can't Predict the Future* (New York: Columbia University Press, 2006)

Steve Fetter, *Climate Change and the Transformation of World Energy Supply* (Palo Alto: Center for International Security and Cooperation, Stanford University, 1999) http://iis-db.stanford.edu/pubs/10228/fetter.pdf, entire study

14 10/20 Policy for stem cell research

Readings to come

15 10/22 Risk assessment, science, and political interests: fine particulates

Jonathan Shaw, "Clearing the Air: How Epidemiology, Engineering, and Experiment Finger Fine Particles as Airborne Killers," *Harvard Magazine*, May-June 2005, pp. 29-35
http://harvardmag.com/pdf/2005/05-pdfs/0505-28.pdf

Cass R. Sunstein, *Risk and Reason: Safety, Law, and the Environment* (Cambridge: Cambridge University Press, 2002), pp. 230-234, 239-243, 313-314, 316.

Emma Marris, "The Politics of Breathing," *Nature*, Vol. 444, 16 November 2006.
http://www.nature.com.ezp-prod1.hul.harvard.edu/nature/journal/v444/n7117/pdf/444248a.pdf

Environmental Protection Agency, *Regulatory Impact Analysis for National Ambient Air Quality Standards* (Washington, D.C.: EPA, 2006), "Executive Summary," pp. ES-1-ES-14.
http://epa.gov/ttn/ecas/regdata/RIAs/Executive%20Summary.pdf

"Study on Greater PM2.5 Impact May Justify Stricter Air Standards," *Environmental Policy Alert*, 17 June 2009.
http://www.lexisnexis.com.ezp1.harvard.edu/us/lnacademic/api/version1/sr?shr=t&csi=297280&sr=HLEAD(stricter+air+standards)+AND+DATE+IS+06/17/2009

World Health Organization, "WHO Air Quality Guidelines for Particulate Matter, Ozone, Nitrogen Dioxide, and Sulfur Dioxide: Global Update 2005: Summary of Risk Assessment" (Geneva: WHO, 2005), pp. 5-13.
http://whqlibdoc.who.int/hq/2006/WHO_SDE_PHE_OEH_06.02_eng.pdf

Suggested:

Jerome C. Arnett, *The EPA's Fine Particulate Matter (PM2.5) Standards, Lung Disease, and Mortality: A Failure of Epidemiology* (Washington, D.C.: Competitive Enterprise Institute, 2006), http://cei.org/gencon/025,05511.cfm
(Extended version of the industry argument that we still do not know that PM2.5 is harmful.)

Bert Brunekreef and Stephen T. Holgate, "Review: Air Pollution and Health," *The Lancet*, Vol. 360, 19 October 2002, pp. 1233-1242.
http://www.lexisnexis.com.ezp1.harvard.edu/us/lnacademic/api/version1/sr?shr=t&csi=154080&sr=HLEAD(air+pollution+and+health)+AND+DATE+IS+10/19/2002

16 10/27 Simulation: Negotiating climate and low-carbon energy legislation

Handouts to be provided before class.

17 10/29 Simulation: Negotiating climate and low-carbon energy legislation

Handouts to be provided before class.

18 11/ 3 Issue: Cybersecurity

Seymour E. Goodman and Herbert S. Lin, eds., *Toward a Safer and More Secure Cyberspace* (Washington, D.C.: National Academy Press, 2007), Executive Summary
http://www.nap.edu/nap-cgi/report.cgi?record_id=11925&type=pdfxsum

William A. Owens, Kenneth W. Dam, and Herbert S. Lin, eds., *Technology, Policy, Law, and Ethics Regarding U.S. Acquisition and Use of Cyberattack Capabilities* (Washington, D.C.: National Academy Press, 2009), Executive Summary
http://www.nap.edu/nap-cgi/report.cgi?record_id=12651&type=pdfxsum

Suggested:
Information Technology for Counterterrorism (Washington, D.C.: National Academy Press: 2003), pp. 10-14, 15-27, 97-105.

Who goes there? Authentication through the Lens of Privacy (Washington, D.C.: National Academy Press: 2003), pp. 16-54, 138-193

The Internet Under Crisis Conditions: Learning from September 11 (Washington, D.C.: National Academy Press: 2004)

19 11/5 Issue: The nuclear energy revival and the risk of proliferation

"Assessing the Proliferation Risks of Civilian Nuclear Programmes," pp. 141-150, "Policy Options for Preventing a Proliferation Cascade," pp. 151-164, in Mark Fitzpatrick, ed., *Nuclear Programmes in the Middle East: In the Shadow of Iran* (London: International Institute for Strategic Studies, 2008)

Matthew Bunn, "Proliferation Resistance (And Terror-Resistance) of Nuclear Energy Systems," lecture to "Systems Analysis of the Nuclear Fuel Cycle," Massachusetts Institute of Technology, Cambridge, Mass., November 20, 2007
http://belfercenter.ksg.harvard.edu/files/uploads/bunn_proliferation_resistance_lecture.pdf

Mohammed ElBaradei, "Nuclear Energy: The Need for a New Framework,"
http://www.iaea.org/NewsCenter/Statements/2008/ebsp2008n004.html

Matthew Bunn, "Civil Nuclear Energy and Nuclear Weapons Programs: The Record" (unpublished memo) http://ocw.mit.edu/NR/rdonlyres/Nuclear-Engineering/22-812JSpring2004/DA39D9C3-72E5-426E-840C-712594207E23/0/prolif_history.pdf

Suggested:

John P. Holdren, "Nuclear Power and Nuclear Weapons: The Connection is Dangerous," *Bulletin of the Atomic Scientists,* Vol. 39, No. 1, January 1983, pp. 40-45.
http://books.google.com/books?id=-AUAAAAAMBAJ&lpg=PA40&pg=PA40#v=onepage&q=&f=false

Bernard I. Spinrad, "Nuclear Power and Nuclear Weapons: The Connection is Tenuous," *The Bulletin of the Atomic Scientists*, Vol. 39, No. 2, February 1983, pp. 42–47. http://books.google.com/books?id=9gUAAAAAMBAJ&lpg=PA42&pg=PA42#v=onepage&q=&f=false

Harold Feiveson, Alexander Glaser, Marvin Miller, and Lawrence Scheinman, *Can Future Nuclear Power be Made Proliferation Resistant?* (College Park, Md.: Center for International and Security Studies at Maryland, University of Maryland, July 2008), http://cissm.umd.edu/papers/files/future_nuclear_power.pdf

Houston G. Wood, Alexander Glaser, and R. Scott Kemp, "The Gas Centrifuge and Nuclear Weapons Proliferation," *Physics Today*, pp. 40-45 http://ptonline.aip.org/journals/doc/PHTOAD-ft/vol_61/iss_9/40_1.shtml

John Deutch, Arnold Kanter, Ernest Moniz, and Daniel Poneman, "Making the World Safe for Nuclear Energy," *Survival*, vol. 46, no. 4 (Winter 2004-2005), pp. 65-80. http://web.mit.edu/chemistry/deutch/policy/68MakingtheWorld2004.pdf

Proliferation Resistance and Physical Protection Evaluation Methodology Expert Group, Generation IV International Forum, *Evaluation Methodology for Proliferation Resistance and Physical Protection of Generation IV Nuclear Energy Systems*, Rev. 5 (Paris: OECD Nuclear Energy Agency, 30 November 2006) http://www.gen-4.org/Technology/horizontal/PRPPEM.pdf

Matthew Fuhrman, "Spreading Temptation: Proliferation and Peaceful Nuclear Cooperation Agreements," *International Security*, Vol. 34, No. 1, Summer 2009, pp. 7-41. http://www.lexisnexis.com.ezp1.harvard.edu/us/lnacademic/api/version1/sr?shr=t&csi=258937&sr=HLEAD(proliferation+and+peaceful+nuclear+cooperation)+AND+DATE+IS+2009

20 11/10 Strengthening S&T education, sustaining a competitive S&T workforce

Dorothy S. Zinberg, "Putting People First: Education, Jobs, and Economic Competitiveness," pp. 235- 265 in Lewis Branscomb, ed., *Empowering Technology: Implementing a U.S. Strategy* (Cambridge, Mass.: MIT Press: 1993).

Committee on Prospering in the Global Economy of the 21st Century, Committee on Science, Engineering, and Public Policy, National Academy of Sciences, National Academy of Engineering, and the National Institute of Medicine *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, (Washington, DC: National Academy Press, 2006). pp. 94-104 [indicators of current state], 112-135 [recommendations on K-12 education], 162-182 [recommendations on higher education] http://www.nap.edu/catalog.php?record_id=11463

21 11/12 Science and technology for development

Task Force on Science, Technology and Innovation, UN Millennium Project (Calestous Juma and Lee Yee-Cheong, lead authors), *Innovation: Applying Knowledge in Development* (London and Sterling, Virginia: Earthscan, 2005), pp. 1-12, 20-44.
http://www.unmillenniumproject.org/documents/Science-complete.pdf

Nevin Cohen, *What Works: Grameen Telecom's Village Phones* (Washington, D.C.: World Resources Institute, 2001), http://www.digitaldividend.org/pdf/grameen.pdf

22 11/17 Issue: The nuclear energy revival and the risk of proliferation

Student presentations

23 11/19 Science and technology in democracies

Sheila Jasanoff, "Political Function of Good Science" in *The 5th Branch: Science Advisors as Policymakers*, (Cambridge, Mass.: Harvard University Press 1990), pp. 229-250.

Richard Sclove, "Town Meetings on Technology," in Daniel Lee Kleinman, ed., *Science, Technology, and Democracy* (Albany: SUNY Press, 2000).

Roger A. Pielke, *The Honest Broker: Making Sense of Science in Policy and Politics* (Cambridge, U.K.: Cambridge University Press, 2007), pp. 1-7, 116-134.

24 11/24 International science, technology, and innovation policies

Jeffrey L. Furman, Michael E. Porter, and Scott Stern, "The Determinants of National Innovative Capacity," *Research Policy*, Vol. 31, No. 6, August 2002, pp. 899-933.
http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.127.8764&rep=rep1&type=pdf

Robert M. May, "The Scientific Investment of Nations," *Science*, Vol. 281, pp. 49-51, 3 July 1998. http://www.sciencemag.org.ezp-prod1.hul.harvard.edu/cgi/content/full/281/5373/49

Japan Research Institute, *Comparative Analysis on S&T Policies and Their Achievements between Major Countries* (Tokyo: National Institute of Science Technology Policy, Ministry of Education, Culture, Sports, Science, and Technology, March 2005)
http://www.nistep.go.jp/achiev/ftx/eng/rep091e/pdf/rep091e.pdf, pp. 1-36.

Lan Xue, "China: The Prizes and Pitfalls of Progress," *Nature*, Vol. 454, No. 7203, pp. 398-401, 24 July 2008.
http://www.nature.com.ezp-prod1.hul.harvard.edu/nature/journal/v454/n7203/pdf/454398a.pdf

Shang Yong (vice minister of Science and Technology), "An Introduction to China's Science and Technology Policy" (presentation), 15 December 2005,
http://belfercenter.ksg.harvard.edu/files/ministershangyong_dec_15_05_lecture.pdf

Suggested:

Alice Amsden, *The Rise of the Rest: Challenges to the West from Late Industrializing Economies*, (New York: Oxford University Press, 2001), Chapter 1. http://www.oxfordscholarship.com.ezp-prod1.hul.harvard.edu/oso/private/content/economicsfinance/9780195139693/p008.html#acprof-0195139690-chapter-1

Carl Dahlman, Bruce Ross-Larson, and Larry Westphal, "Managing Technological Development: Lessons from Newly Industrializing Countries," *World Development,* Vol. 15, No. 6, 1987, pp. 759-775; http://ezp-prod1.hul.harvard.edu/login?url=http://dx.doi.org/10.1016/0305-750X(87)90058-1?nosfx=y

Gabriela Dutrénit,and Jorge Katz, "Innovation, Growth and Development in Latin-America: Stylized Facts and a Policy Agenda," *Innovation: Management, Policy & Practice,* Vol. 7, No. 2-3, April 2005. http://www.entrepreneur.com/tradejournals/article/158527352.html

11/26 HOLIDAY -- THANKSGIVING

25 12/1 Globalization of science and technology

Booz Allen Hamilton and INSEAD, "Innovation: Is Global the Way Forward?" (McLean, VA: Booz Allen Hamilton, 2006)
http://www.boozallen.com/media/file/Innovation_Is_Global_The_Way_Forward_v2.pdf

Robert Rycroft, "Self-Organizing Innovation Networks: Implications for Globalization" (Washington, D.C.: George Washington University, 2003)
http://www.gwu.edu/~cistp/assets/docs/research/articles/SelfOrganizing_RWR_2.24.03.pdf

26 12/3 What have we learned? And careers in science and technology policy

Readings to come