IGA-503M
GOVERNING SCIENCE AND TECHNOLOGY RISKS AND CHALLENGES

Prof. Matthew Bunn
matthew_bunn@harvard.edu

Fall 2010

SYLLABUS

Class meets M/W 10:10-11:30 in L332

Overview

From oil gushing into the deep ocean to cyberterrorism, from outbreaks of infectious disease to climate change, policymakers worldwide must develop policies to manage risks and challenges in which science and technology are central drivers. Though generally not technical experts, they must be able to grasp the key features of these risks, recognize the intricacies of complex systems, reach out for appropriate expertise and advice, and integrate insights from science and technology into the broader political and policy framework. This course will help provide the tools needed to manage and regulate science and technology-related risks, including: different perspectives on risk assessment; an introduction to how complex systems behave; the strengths and weaknesses of models for public policy; scientific advisory processes; and approaches to managing complex science and technology issues in democratic societies. Students will explore these issues through case studies ranging from the science, economics, and politics of climate change to nuclear proliferation. The course's coverage is global (though with a heavier focus on the United States). No previous technical background is required. There are no prerequisites, though the course is designed to work in sequence with (and not to overlap) Promoting Science, Technology, and Innovation, offered in the first half of the semester.

Students will be encouraged to participate in in-class and on-line discussions, and to hone their writing, research, 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 instructor; the diversity of backgrounds enriches the course.

The course assistant for this course is Gabe Chan (gabe_chan@hksphd.harvard.edu, 415-533-6103); he can help you with any questions you may have. Professor Bunn's office hours will be Monday and Wednesday 2-3:30 in L339C. 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 Ashley Gagné (617-495-8850, ashley_gagne@hks.harvard.edu) indicating the topic you would like to discuss.

Assignments and Grading

There are four short assignments for this course. The first assignment is a group briefing on an assigned science and technology (S&T) policy challenge; the second is a brief reflection on the policy simulation students will take part in (described below); the third is a policy memo

on another S&T policy challenge; and the fourth is a short research paper on a topic chosen by the student, focusing on the approach to managing a major S&T-related risk or challenge in a country other than the United States.

Each student will participate 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.

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 instructor grants an exception due to special circumstances. The assignments will be due on the following dates:

Group briefing: 11/8

Reflection on climate simulation: 11/22

Policy memo: 11/29

Short paper: 12/8

(Note: each student should choose a topic for the paper by 10/29, and provide an outline by 11/12; students may choose to make brief presentations on their paper topics in class on 11/29, which will add to their class participation rating and provide comments from the class which may be useful in completing the paper.)

Grading for this course is as follows:

Group briefing: 20%

Policy memo: 20%

Simulation: 15%

Short paper: 25%

Class participation: 20%

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 policymaking careers in general, and for careers involving science and technology in particular. 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 the professor, 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, with serious consequences. Real policy memos you will right in your careers typically will not have footnotes; the ones in this class must, however, and throughout your career, it is always worthwhile to keep track of where you acquired particular facts and insights.

Class schedule

Class	Date	Topic	Speaker
1	10/20	A world of complex challenges with S&T drivers: Gulf spill case	MB
2	10/25	Complex socio-technical systems: Gulf spill case	MB
3	10/27	Risk assessment and cost-benefit analysis in regulation	MB
4	11/1	Risk assessment, science, and political interests: fine particulates	MB
5	11/3	Sources of S&T advice and analysis (interest groups, NGOs, private sector, science advisory bodies, universities, individuals)	MB
6	11/8	Governing global S&T risks and challenges: case studies	MB
7	11/10	Strengths and weaknesses of models: response to climate	MB
8	11/15	Issue: Cybersecurity	Guest
9	11/17	Simulation: Negotiating climate and low-carbon energy legislation	MB
10	11/22	Simulation: Negotiating climate and low-carbon energy legislation	MB
11	11/24	Issue: The nuclear energy revival and the risk of nuclear proliferation	MB
12	11/29	Democratic management of S&T risks and challenges: case studies	MB
13	12/1	What have we learned? And careers in S&T policy	MB

IGA-503M READINGS

There is no textbook for this course. Most of the course readings are available on the internet, at links provided below. Those that are not will be available in a packet from the Course Materials Office. Some readings will be added or subtracted as the semester proceeds.

1 10/20 A world of complex challenges with S&T drivers: Gulf spill case

Required:
David Barstow, Laura Dodd, James Glanz, Stephanie Saul, and Ian Urbina, "Regulators Failed to Address Risks in Oil-Rig Fail-Safe Device," *New York Times,* 20 June 2010.
http://www.nytimes.com/2010/06/21/us/21blowout.html

Michael A. Roberto, Richard M.J. Bohmer, and Amy C. Edmondson, "Facing Ambiguous Threats," *Harvard Business Review,* Vol. 84, No. 11 (November 2006).
http://ezp-prod1.hul.harvard.edu/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=heh&AN=22671298&site=ehost-live&scope=site

"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:
"Documents on the Oil Spill" (risk assessments related to the Deepwater Horizon rig and the technologies used to prevent deep water oil spills, compiled and annotated in support of the 20 June *New York Times* story).
http://documents.nytimes.com/documents-on-the-oil-spill?ref=us

"Investigating the Cause of the Deepwater Horizon Blowout"
(Helpful diagrams and explanatory video, also in support of the 20 June *New York Times* story).
http://www.nytimes.com/interactive/2010/06/21/us/20100621-bop.html

Suggested readings on deepwater drilling compiled by Gabe Chan (posted on class page, with links)

2 10/25 Complex socio-technical systems: Gulf spill case

Required:

John D. Sterman, "Learning From Evidence in a Complex World," *American Journal of Public Health,* Vol. 96, No. 3 (March 2006), p. 505-514. (How thinking in the framework of complex dynamic systems can help in real-world public policy problems – a short introduction.)

John D. Sterman, "Economics: Risk Communication on Climate: Mental Models and Mass Balance," *Science,* 24 October 2008
http://www.sciencemag.org.ezp-prod1.hul.harvard.edu/cgi/content/full/sci;322/5901/532
(Discusses how badly most people understand systems with stocks and flows.)

John D. Sterman et al., "Greenhouse Gas Emissions Simulator"
http://scripts.mit.edu/~jsterman/climate/master/

(Allows you to try your hand yourself at stabilizing greenhouse gas concentrations, a classic problem of stocks and flows.)

John D. Sterman, "Time Delay Simulator"
http://jsterman.scripts.mit.edu/Management_Flight_Simulators_%28MFS%29.html
(Allows you to try your hand at controlling a simple system with a time lag – remarkably difficult to do.)

U.S. Department of the Interior, *Increased Safety Measures for Energy Development on the Outer Continental Shelf* (Washington, D.C.: U.S. DOI, 27 May 2010). (skim)
http://www.doi.gov/deepwaterhorizon/loader.cfm?csModule=security/getfile&PageID=33598

Jason DeParle, "Minerals Service Had a Mandate to Produce Results," *New York Times,* 7 August 2010.
http://www.nytimes.com/2010/08/08/us/08mms.html

Juliet Eilperin and Steven Mufson, "White House Lifts Ban on Deepwater Drilling," *Washington Post,* 12 October 2010
http://www.washingtonpost.com/wp-dyn/content/article/2010/10/12/AR2010101202326.html

Michael Leahy and Juliet Eilperin, "Obama and Oil Drilling: How Politics Spilled Into Policy," *Washington Post,* 12 October 2010
http://www.washingtonpost.com/wp-dyn/content/story/2010/10/12/ST2010101202909.html

Suggested:

James P. Crutchfield, "The Hidden Fragility of Complex Systems: Consequences of Change, Changing Consequences," October 2009
http://cse.ucdavis.edu/~cmg/papers/FOCS.pdf

Robert Jervis, *System Effects: Complexity in Political and Social Life* (Princeton, N.J.: Princeton, 1997)

Homeland Security Institute, *Homeland Security Risk Assessment: Vol. II: Methods, Techniques, and Tools,* RP05-024-01b (Arlington, VA: Homeland Security Institute, June 2006)
(Provides very useful few-page summaries of different risk assessment approaches, including adaptive agent modeling and network analysis among others, with summaries of key references and links to relevant software.)
http://www.homelandsecurity.org/hsireports/Risk%20Assessment%20Volume%202%20Methods%20Techniques%20and%20Tools.pdf

U.S. Department of Interior, "Salazar Announces Regulations to Strengthen Drilling Safety, Reduce Risk of Human Error on Offshore Oil and Gas Operations," 30 September 2010 (with links to fact sheets describing the new regulations, and other reforms of offshore drilling)
http://www.doi.gov/news/pressreleases/Salazar-Announces-Regulations-to-Strengthen-Drilling-Safety-Reduce-Risk-of-Human-Error-on-Offshore-Oil-and-Gas-Operations.cfm

Michael R. Bromwich, Director, Bureau of Ocean Energy Management, Regulation, and Enforcement, "Report Regarding the Current Suspension of Certain Offshore Permitting and Drilling Activities in the Offshore Continental Shelf," 1 October 2010 ("October 1 Report") (posted on class page)

3 10/27 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://papers.ssrn.com.ezp-prod1.hul.harvard.edu/sol3/papers.cfm?abstract_id=622962

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.

Sheila P. Jasanoff, "Trading Uncertainities: The Transatlantic Divide in Regulating Biotechnology," *CESifo DICE Report,* February 2008, pp. 36-43.
http://www.cesifo-group.de/pls/guestci/download/CESifo DICE Report 2008/CESifo DICE Report 2/2008 /dicereport208-rr2.pdf

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.

Paul Slovic, "Going Beyond the Red Book: The Sociopolitics of Risk," *Human and Ecological Risk Assessment*, Vol. 9, No. 5, 2003, pp. 1-10.
http://yosemite.epa.gov/SAB/sabcvpess.nsf/0/8fa712e385e8c06385256ddd005687a9/$FILE/508.pdf

Committee on Improving Risk Analysis Approaches Used by the U.S. EPA, National Research Council, *Science and Decisions: Advancing Risk Assessment* (Washington, D.C.: National Academy Press, 2009), "Summary."
http://www.nap.edu/catalog.php?record_id=12209

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://www.nber.org/papers/w9487.pdf

4 11/1 Risk assessment, science, and political interests: fine particulates

Required:

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
(Note: A similar impact analysis for the current review of fine particulate standards has not yet been published)

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:

U.S. Environmental Protection Agency, *Policy Assessment for the Review of the Particular Matter National Ambient Air Quality Standards – Second External Review Draft* (Washington, D.C.: EPA, June 2010)
http://www.epa.gov/ttnnaaqs/standards/pm/data/20100630seconddraftpmpa.pdf

Clean Air Science Advisory Committee, "CASAC Review of *Policy Assessment for the Review of the PM NAAQS – Second External Review Draft* (June 2010)" (Washington, D.C.: EPA, 10 September 2010)
http://yosemite.epa.gov/sab/sabproduct.nsf/264cb1227d55e02c85257402007446a4/CCF9F4C0500C500F8525779D0073C593/$File/EPA-CASAC-10-015-unsigned.pdf

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

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

5 11/3 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

Sheila Jasanoff, "Testing Time for Climate Science," *Science,* Vol. 328 (7 May 2010), pp. 695-696.

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.

Sheila Jasanoff, "The Essential Parallel Between Science and Democracy," *SEED Magazine,* 17 February 2009
http://seedmagazine.com/content/print/the_essential_parallel_between_science_and_democracy/

Suggested:

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

Ron Oxburgh, chair, *Report of the International Panel Set Up by the University of East Anglia to Examine the Research of the Climate Research Unit* (East Anglia, UK: University of East Anglia, 14 April 2010).
http://www.uea.ac.uk/mac/comm/media/press/CRUstatements/SAP

Muir Russell, chair, *The Independent Climate Change E-Mails Review* (East Anglia, UK: University of East Anglia, 7 July 2010).
http://www.cce-review.org/pdf/FINAL%20REPORT.pdf (esp. 10-16, "Executive Summary")

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).

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://carnegie.org/fileadmin/Media/Publications/PDF/Facing%20Toward%20Governments%20Nongovernmental%20Organizations%20and%20Scientific%20and%20Technical%20Advice.pdf

6 11/8 Governing global S&T risks and challenges: case studies

Readings to come. Examples such as ozone depletion, infectious disease, and security for nuclear materials.

7 11/10 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/index.htm

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.

8 11/15 Issue: Cybersecurity

Mark Bowden, "The Enemy Within," *The Atlantic,* June 2010 (account of the "conficker" worm).
http://www.theatlantic.com/magazine/archive/2010/06/the-enemy-within/8098/

Joseph S. Nye, Jr., *Cyber Power* (Cambridge, Mass.: Belfer Center for Science and International Affairs, Harvard Kennedy School, May 2010).
http://belfercenter.ksg.harvard.edu/files/cyber-power.pdf

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:

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

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).

9 11/17 Simulation: Negotiating climate and low-carbon energy legislation

Handouts to be provided before class.

10 11/22 Simulation: Negotiating climate and low-carbon energy legislation

Handouts to be provided before class.

11 11/24 Issue: The nuclear energy revival and the risk of nuclear 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). On course webpage.

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://www.ingentaconnect.com.ezp-prod1.hul.harvard.edu/content/routledg/surviv/2004/00000046/00000004/art00004

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

12 11/29 Democratic management of S&T risks and challenges: case studies

Sheila Jasanoff, "The 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.

13 12/1 What have we learned? And careers in S&T policy

Readings to come.