

Scientific Knowledge, Risk and Decision-Making

Spring Semester, 2006

Maxine Goodman Levin College of Urban Affairs

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Wednesday 6:00 – 9:50

Course Description and Objectives

Risk is a ubiquitous feature of human life. It is presented to us in the form of terrorism, nuclear power, environmental pollution, habitat loss, global warming, airplane and automobile crashes, carcinogens and endocrine disruptors, to name but a few. This is an interdisciplinary survey of a range of literature in philosophy, psychology, decision-theory, economics, cognitive science, operations research and public policy, all of which is related to the theory and practice of making decisions under risk and uncertainty. Reference is made to the philosophy literature because it contains clarification of many of the fundamental principles and concepts. Reference is made to the psychology literature because, realistically, the subjective judgmental dimension of risk assessment means that the psychology of the individual assessor is an inescapable fact of risk analysis, regardless of one's level of expertise. Reference is made to the decision-theoretic literature because the theory of risk evaluation and management is a department of a wider theory of decision-making. Reference is made to the economics literature because of the long history of the formal theory of choice under risk and uncertainty found in economics. Reference is made to the cognitive science literature because cognitive processes distinguish the beliefs and judgments of experts from those of laymen, and because this distinction is pivotal in much risk-based decision-making, as well as in the rhetoric of public policy. Reference is made to the operations research literature because in it is found much of the mathematical basis of the normative decision-making models developed in the twentieth century. Finally, reference is made to the public policy literature because when one turns from the level of individual risk-based decision making to the collective level of planning and public policy formulation in the society as a whole, risk-related considerations can be decided only through the operation of the political process.

The course is neither a comprehensive treatise on risk, nor a practitioners' guide that offers a survey of the tricks of the trade of risk assessment and/or risk management. Instead it aims to develop core themes and conceptual structure that synthesize and integrate subject matter related to scientific knowledge, risk evaluation, risk-management, and decision-making across and between the aforementioned disciplines. The idea is to bring these themes and this conceptual structure meaningfully within the purview of the minds of course participants. A primary goal is to enhance the capability of course participants to make fully conceptualized and informed decisions about key issues that affect the world today. The course seeks to achieve this goal largely by elucidating the difficulties and obstacles that must be overcome to render a coherent understanding of the process of decision-making under risk and uncertainty, the

contributions of scientific knowledge to risk-based decision-making, and the role of risk-based decision-making in planning and public policy. Class participants will be given wide latitude in framing these themes and structures, in discovering and pursuing their multiple constituent dimensions, and in making these dimensions a part of their articulate repertoire. They will also be encouraged to make connections between their frames and the accumulated body of knowledge in the disciplines. This will make it clear that a whole host of conceptual and evaluative issues must be decided before any systematic design methodology can be specified and used intelligibly to compensate for limitations on the unaided human cognitive potentials in the process of risk-based decision making. It will also illuminate just how thin the egg shells upon which one walks are when one uses the risk assessor practitioner's usual tools.

Selected Sources of Course Readings

Arkes, Hal R. and Kenneth R. Hammond (editors) (1986). *Judgment and Decision-Making: An Introductory Reader*. Cambridge: Cambridge University Press.

Beach, Lee Roy and Terry Connolly (2005). *The Psychology of Decision Making : People in Organizations*, 2nd edition (Foundations for Organizational Science). Thousand Oaks, California; Sage Publications.

Kahneman, Daniel, Paul Slovic, and Amos Tversky (1982). *Judgment under uncertainty: Heuristics and Biases*. New York: Cambridge University Press.

Rescher, Nicholas (1983). *Risk: A Philosophical Introduction to the Theory of Risk Evaluation and Management*. New York: University Press of America.

History of Economic Thought website. New School for Social Research in New York City: www.cepa.newschool.edu/het/

Course Format, Requirements and Grading

This is not a course in which the instructor lectures, the students memorize the content of the lecture, and grades are based upon regurgitating the content of the lectures on exams. The format will be seminar style. Each week in class, the instructor will introduce the material, and then with the help of the next week's assigned discussion co-leader, the entire class will discuss the material. Thus it is expected that students will read all materials, prepare to ask questions about them and to discuss and argue about them, and will be fully ready to actively participate in class. Grades will be based 60% upon class participation and 40% upon a course research paper..

Tentative Schedule

Part I. Preliminaries

This section provides a general introduction to risk-based decision-making.

A Seemingly Plausible Model of the Risk-Based Decision-Making Process (January 18)

Read: Ruckelshaus, William D. (1983). Science, Risk, and Public Policy. *Science*. September 9;221(4615):1026-8

Chauncey Starr (1969). Social Benefits versus Technological Risk, *Science* 165: pp 1232 - 1238.

March, James G. (1982). Theories of Choice and Making Decisions. *Society*. November/December. pp. 29 – 39.

Beach and Connolly, Chapter 1. Preliminaries

Beach and Connolly, Chapter 2. Framing

Beach and Connolly, Chapter 3. Policy

Beach and Connolly, Chapter 4. Choice

Rescher. Chapter 1. The Nature of Risk.

Bradbury, Judith A. (1989). The Policy Implications of Differing Concepts of Risk. *Science, Technology, and Human Values* 14 (4): pp. 380 – 399.

Elements of Risk Evaluation (January 25)

Read: Rescher. Chapter 2. Negativity Evaluation and Comparison

Rescher. Chapter 3. Probability and its Ramifications

Rescher. Chapter 4. Risk Evaluation and Comparison: The Orthodox Theory

Richard Layard and Stephen Glaister (1994). Introduction to Cost-Benefit Analysis. In Richard Layard and Stephen Glaister (editors). *Cost-Benefit Analysis*, 2nd Edition. Cambridge: Cambridge University Press. pp. 1 – 56

K. J. Arrow and R.C. Lind (1994). Risk and Uncertainty: Uncertainty and the Evaluation of Public Investment Dollars. In Richard Layard and Stephen Glaister (editors). *Cost-Benefit Analysis*, 2nd Edition. Cambridge: Cambridge University Press. pp. 160 - 178

“General Introduction to Choice Under Risk and Uncertainty” and “Bernoulli and the St. Petersburg Paradox”. Found in the pages on Uncertainty, Information and Games on the History of Economic Thought website. Department of Economics. New School of Social Research. New York, New York.
<http://cepa.newschool.edu/het/essays/uncert/uncerthome.htm>

Fundamentals of Risk Management: (February 1)

Read: Rescher. Chapter 5. Disparate Risks, Catastrophes, and the Limitations of Expected Value Analysis
Rescher. Chapter 6. Insurance Against Catastrophe
Rescher. Chapter 7. Risk Dilemmas
Rescher. Chapter 8. Uncertainty
Rescher. Chapter 9. Risk Management Strategies: The Interrelation of Rules

Christian D. Schunn, Susan S. Kirschenbaum, and J. Gregory Trafton (2003). *The Ecology of Uncertainty: Sources, Indicators and Strategies for Informational Uncertainty*. Pittsburg, Pennsylvania: Naval Research Laboratory
www.au.af.mil/au/awc/awcgate/navy/nrl_uncertainty_taxonomy.pdf

Zeleny, Milan (1982). *Multiple Criteria Decision Making*. Chapter 3: The Decision Process and Its Stages (pp. 85 – 97). New York: McGraw-Hill Book Company.

Part II. Rationality and Risk: Normative and Descriptive Camps

This section introduces the formal mathematical foundations of the concept of rational choice, reviews some of the research that demonstrates the differences between the demands on choice established by these foundations and the actual performance of human beings making choices, and in doing so makes elementary distinctions between the normative and descriptive views of risk and rationality.

The Normative Camp: Linear Programming, von Neumann-Morgenstern Expected Utility Theory, Objections to its Ostensibly Objective Foundations, and Subjective Expected Utility (February 8)

Read: Robert Dorfman (1985). Mathematical, or “Linear” Programming: A Nonmathematical Exposition. In *Microeconomics: Selected Readings* (Edited by Edwin Mansfield). New York: W.W. Norton and Company. pp. 161 – 188.

Beach and Connolly, Chapter 5. Subjective Probability and Utility

“The Early Debates,” “Alternative Expected Utility” and “Subjective Expected Utility.” Found in the section on Uncertainty, Information and Games on the History of Economic Thought website. Department of Economics. New School of Social Research. New York, New York.

<http://cepa.newschool.edu/het/essays/uncert/uncerthome.htm>

The Descriptive Camp: Psychological Studies of Judgment Under Uncertainty (February 15)

Read: Beach and Connolly, Chapter 6. Heuristics and Biases and Prospect Theory

Amos Tversky and Daniel Kahneman. Judgments under uncertainty: Heuristics and Biases. In Kahneman, Daniel, Paul Slovic, and Amos Tversky (1982). *Judgment under uncertainty: Heuristics and Biases*. New York: Cambridge University Press. pp. 3 – 22.

Daniel Kahneman and Amos Tversky. Subjective Probability: A judgment of representativeness. In Kahneman, Daniel, Paul Slovic, and Amos Tversky (1982). *Judgment under uncertainty: Heuristics and Biases*. New York: Cambridge University Press. pp. 32 – 47.

Ward Edwards and Detlof von Winterfeldt. On Cognitive Illusions and their Implications. In Arkes, Hal R. and Kenneth R. Hammond (editors) (1986). *Judgment and Decision-Making: An Introductory Reader*. Cambridge: Cambridge University Press. pp. 647 – 679.

Ward Edwards. Conservation in human information processing. In Kahneman, Daniel, Paul Slovic, and Amos Tversky (1982). *Judgment under uncertainty: Heuristics and Biases*. New York: Cambridge University Press. pp. 359 – 369.

Jungerman, Helmut (1986). The two camps on rationality. In Hal R. Arkes and Kenneth R. Hammond (editors). *Judgment and Decision-Making: An Interdisciplinary Reader*. New York: Cambridge University Press. pp 627 – 641

Part III. Scientific Knowledge and Value Judgment in Decision Processes

This section focuses upon the distinction between the risk assessments of experts, on one hand, and lay people on the other. It considers the hypothesis that the difference between them is found in the degree to which it is assumed that the two groups employ fallible cognitive processes in making the assessments.

The Informational and Predictive Basis of Risk-Based Decisions (February 22)

Read: Frederick von Hayek (1945). The Use of Knowledge in Society. *The American Economic Review* XXXV (4): 519 – 530.

Dawes, Robyn N. The robust beauty of improper linear models in decision-making. In Kahneman, Daniel, Paul Slovic, and Amos Tversky (1982). *Judgment under uncertainty: Heuristics and Biases*. New York: Cambridge University Press. pp. 391 – 407.

Einhorn, Hillel J. (1986). Expert judgment: some necessary conditions and an example. In Hal. R. Arkes and Kenneth R. Hammond (editors), *Judgment and decision-making: An introductory reader*. Cambridge: Cambridge University Press. pp 480 – 491.

Robert Glaser and Michelene T.H. Chi (1988). Introduction: What is it to be an Expert? In Michelene T.H. Chi, Robert Glaser, and M. J. Farr, *The Nature of Expertise*. Hillsdale, New Jersey. pp. xv – xxxvii.

Sjoberg, Lennart (2002). The Allegedly Simple Structure of Experts' Risk Perceptions: An Urban Legend in Risk Research. *Science, Technology, and Human Values* 27 (4); 443 – 459.

Kenneth R. Hammond, Barry F. Anderson, Jeffrey Sutherland, and Barbara Marvin (1986). Improving scientists' judgments of risk. In Hal. R. Arkes and Kenneth R. Hammond (editors), *Judgment and decision-making: An introductory reader*. Cambridge: Cambridge University Press. pp 466 – 479

Theodore R. Sarbin, Ronald Taft, and Daniel E. Bailey (1960). *The Logic of Clinical Inference*. Clinical Inference and Cognitive Theory. New York. Holt, Rinehart and Winston, Inc.

The Normative-Affective Aspects of Risk-Based Decisions (March 1)

In this session we consider values, emotions, passions and habits of mind and their influences upon risk-based decision-making.

Read: Beach and Connolly, Chapter 7. Emotions

Daniel Kahneman and Amos Tversky (1986). Choices, values and frames. In Hal. R. Arkes and Kenneth R. Hammond (editors), *Judgment and decision-making: An introductory reader*. Cambridge: Cambridge University Press. pp. 194 – 210.

Kenneth R. Hammond and Leonard Adelman (1986). Science, values, and human judgment. In Hal. R. Arkes and Kenneth R. Hammond (editors), *Judgment and decision-making: An introductory reader*. Cambridge: Cambridge University Press. pp127 - 143

David Gauthier (1975). Reason and Maximization. *Canadian Journal of Philosophy* 4: 418. (ISSN 00455091)

Amitai Etzioni (1992). Normative-Affective Factors: Toward a New Decision-Making Model. In Mary Zey (editor), *Decision Making: Alternatives to Rational Choice Models*. Newbury Park, California: Sage Publications: pp 89 – 111.

Wildavsky, Aaron (1987). Choosing Preferences by Constructing Institutions: A Cultural Theory of Preference Formation. *The American Political Science Review* 81(1): pp 3-21.

Part IV. Integrating Information, Knowledge, and Values in Risk-Based Decisions

This section examines a couple of the prominent ways that people have thought about how the informational and evaluative aspects of decisions are integrated into a choice of action in situations characterized by risk and uncertainty.

Multiattribute Utility Analysis (March 8)

Read: Ward Edwards and J. Robert Newman (1986). Multiattribute Evaluation. In Hal. R. Arkes and Kenneth R. Hammond (editors), *Judgment and decision-making: An introductory reader*. Cambridge: Cambridge University Press. pp. 13 – 37.

Miley W. Merkhofer and Ralph L. Keeney (1987). A Multiattribute Utility Analysis of Alternative Sites for the Disposal of Nuclear Waste. *Risk Analysis* 7 (2); pp 173 – 194.

Zeleny, Milan (1982). *Multiple Criteria Decision Making*. Chapter 12: Multiattribute Utility Measurement (pp. 409 – 445). New York: McGraw-Hill Book Company.

The Analytical Hierarchy Process (March 29)

Read: Thomas Saaty (1988). Chapters 1 and 2. *The Analytic Hierarchy Process: Planning, Priority Setting, Resource Allocation*.

Thomas L. Saaty and H. Golamnezhad (1982). High-level Nuclear Waste Management: Analysis of Options. *Environment and Planning B*, 9(2), 181 – 196.

Thomas L. Saaty (1987). Risk: Its Priority and Probability: The Analytic Hierarchy Process. *Risk Analysis*, 7 (2); 159 – 172.

Psychologically Oriented Models of Judgment and Decision (April 5)

Read: Norman H. Anderson (1991). A Cognitive Theory of Judgment and Decisions. *Contributions to Information Integration Theory*. Hillsdale, New Jersey: Erlbaum Associates

Daniel Kahneman and Amos Tversky (1979). Prospect Theory: An Analysis of Decision Under Risk. *Econometrica* 47 (2); pp. 263 – 291.

Zeleny, Milan (1982). Theory of the Displaced Ideal. *Multiple Criteria Decision Making*. New York: McGraw-Hill Book Company. pp. 130 - 151

Zeleny, Milan (1982). Displaced Ideal: An Operational Model. *Multiple Criteria Decision Making*. New York: McGraw-Hill Book Company. pp. 152 – 183.

Part V. Risk, Uncertainty, Decision-Making and Public Policy

Earlier sections have focused upon specific elements of the thought processes in which individuals facing a risky situation, the ways they are organized more or less logically and systematically, deliberated upon, and utilized in making a choice between actions. The point has been clearly made that risk-based decision-making requires more than just a set of analytical tools rationally applied. It demands a new way of looking at technological and environmental uncertainty. In this section, the focus is instead upon the interaction between the information, preferences and values held by individuals as members of groups and organizations, including especially the aggregation of information, preferences and values from individual level manifestation and their transformation to collective outcomes. While efforts to intelligently pursue appropriate objectives in the face of risk and uncertainty are almost invariably implemented through collective human action, the notion of which is both intuitive and entirely coherent, there is no sense whatsoever in the notion of joint thoughts. Thus, risk management must incorporate the competing interests, values and rationalities of those involved and find a balance of trust and acceptable risk. In the presence of risk and uncertainty, the success of plans and public policies depends not only upon improvements in the quality of thought of individuals making decisions, but also upon the prevailing characteristics of the cultures, organizations, and institutions through which individual level thoughts are made manifest and aggregated into collective outcomes.

Politics, Risk, and Collective Decisions (April 12)

Kenneth J. Arrow. Rationality of Self and Others in an Economic System. In Mary Zey (editor), *Decision Making: Alternatives to Rational Choice Models*. Newbury Park, California: Sage Publications: pp 63 – 111.

Beach and Connolly, Chapter 8. Interpersonal, Organizational, and Group Decisions.

Beach and Connolly, Chapter 9. Alternatives to Gambling.

Carlo C Jaeger, Ortwin Renn, Eugene A Rosa, Thomas Webler (editors) (2001). Risky Decisions of Interacting Agents. *Risk, Uncertainty, and Rational Action*. James & James/Earthscan. pp. 121 - 149

Rescher Chapter 12, The Politics of Risk

Larry L. Kiser and Elinor Ostrom (1985). Three Worlds of Action. A Metatheoretical Synthesis of Institutional Approaches. In Kingsley E. Haynes, Antoni Kuklinski and Olli Kultalahti (editors), 73 – 105. *Pathologies of Urban Processes*. Finland: Finnpublishers.

Resolving Risk-Based Conflict (April 19)

Read: The City of New York and the State of New York ET AL. v. The United States Department of Transportation ET AL. and Commonwealth Edison Company, ET AL. (1983). 2nd Circuit Court of Appeals

Paul Slovic (1999). Trust, emotion, sex, politics, and science: surveying the risk-assessment battlefield. Slovic P. Decision Research, Eugene, Oregon 97401, USA. *Risk Analysis* 1999 Aug;19(4):689-701.

http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=10765431&dopt=Citation

Sheila Jasanoff and Dorothy Nelkin (1987). Science, Technology, and the Limits of Judicial Competence. In Robert W. Lake (Editor), *Resolving Locational Conflict*. New Brunswick, New Jersey: Center for Urban Policy Research. pp 60 – 74.

Howard Kunreuther, Joanne Linnerooth, and James W. Vaupel (1987). A Decision-Process Perspective on Risk and Policy Analysis. In Robert W. Lake

(Editor), *Resolving Locational Conflict*. New Brunswick, New Jersey: Center for Urban Policy Research. pp 260 – 274.

Douglas Maclean (1987). Risk and Consent: Philosophical Issues for Centralized Decisions. In Robert W. Lake (Editor), *Resolving Locational Conflict*. New Brunswick, New Jersey: Center for Urban Policy Research. pp 45 – 59.

Jeremy L. Mennis (2005). The Distribution and Enforcement of Air Polluting Facilities in New Jersey. *The Professional Geographer*, 57 (3): 411 – 422.

Risk, Uncertainty, and Terrorism (May 3)

Henry H. Willis, Andrew R. Morral, Terrence K. Kelly, Jamison Jo Medby (2005). *Estimating Terrorism Risk* (Summary). Arlington, Virginia: Rand Center for Terrorism Risk Management Policy.

W. Kip Viscusi and Richard J. Zeckhauser (2003). Sacrificing Civil Liberties to Reduce Terrorism Risks. *The Journal of Risk and Uncertainty* 26 (2/3): pp. 99 – 120.

Nathaniel O. Keohane and Richard J. Zeckhauser (2003). The Ecology of Terror Defense. *The Journal of Risk and Uncertainty* 26 (2/3): pp. 201 – 229.

Cass R. Sunstein (2003). Terrorism and Probability Neglect. *The Journal of Risk and Uncertainty* 26 (2/3): pp. 121 - 136

Baruch Fischhoff, Roxana M. Gonzalez, Deborah A. Small, and Jennifer S. Lerner (2003). Judged Terror Risk and Proximity to the World Trade Center. *The Journal of Risk and Uncertainty* 26 (2/3): pp.137 – 151.