UNIVERSITY OF DENVER GRADUATE SCHOOL OF INTERNATIONAL STUDIES

Professor Barry Hughes
With Mohammod T. Irfan
Spring, 2006 in BMC 301
Tuesdays 2:00-5:00
Office Hours in BMC 214: M 11:00-12:30, W 11:00-12:30

**INTS 4345 (CRN#2364): The Art of Forecasting**

There is a strong need in both the private and public sectors for individuals who (1) understand how forecasting is done in order to interpret and evaluate it and (2) can themselves develop and present forecasts of various kinds in support of policy analysis and decision-making. The objective of this course is to help students acquire such skills and an understanding of their strengths, weaknesses, and applicability.

**Required Materials**

Jerome C. Glenn and Theodore J. Gordon, eds. *Futures Research Methodology*, version 2. CD. AC/UNU Millennium Project. ISBN 0-9722051-1-X. Price $49.95 plus $3.95 shipping. Under arrangement with Jerome Glenn, students will pay $10 each for a copy of the CD.

Barry B. Hughes, 2006. International Futures (IFs). CD. No charge for class members.

All other readings/materials are available on reserve and/or on the web.

**Prerequisites**

All students must have computer access and basic skills. Ideally, students should have their own computers and there will be three sessions in which use of laptop computers in the classroom would be helpful.

**Course Requirements and Grading.**

This course is a skills-building course and therefore requires an active learning-by-doing approach. You will build towards a final report by producing interim products (deliverables) at roughly two-week intervals. Each of four interim products will be graded and will account for 15% of the course grade. The final report will account for 40% of the course grade.

Forecasting techniques can be highly technical, but many, perhaps even most, are not. As the title suggests, this class is meant for students who want to understand the "art" of forecasting and minimally want to be intelligent consumers of forecasts. We will make available information about and some instruction in the use of more technical approaches, but such approaches will not dominate the course. In addition, grading in the course will not require use of the more mathematical approaches. Grading will, however, require serious effort to do forecasting and to develop new capabilities, whatever your initial base strengths may be.

Most of the sessions are organized roughly into two parts. One half of most sessions has a learning/sharing format in which we learn from a guest lecturer, collectively try new tools, or share with each other the advances we have made in our interim products/deliverables. The other half of most sessions uses readings to discuss tools and their application.

The final paper is due on June 2 (NO extensions). The paper should be presented as a forecasting analysis for a specific client (business, government agency (local, national, international), NGO, research institute, etc.). The paper should have the following components (see the evaluation sheet at the end of the syllabus for more detail):

- A well-defined substantive question that could reasonably be expected to be of significant interest to an identified client.
- A review of previous and related studies and forecasts
- A methodological analysis of forecasting options and discussion of that/those chosen.
- The forecast and analysis, presenting more than one scenario (or an analysis of potential error of the forecast).

The paper should be **a maximum of 30 pages** for all components beyond the title page and table of contents: text, figures, bibliography, and appendices. The paper should have the clear character of a professional report (abstract, table of contents, etc.) It should be single spaced with double spacing between paragraphs.

**March 28. Session 1. Introduction.**

We survey the purposes of the course, the approaches, and the requirements. We learn about each other.

This session would normally last the entire three hours. Because of travel the week of April 4, we will meet from 2:00-6:00 (one hour extra).

**April 4. Session 2. Forecasting Interests of Hughes and Irfan [will probably be rescheduled because Hughes will be attending a forecasting workshop at IIASA outside Vienna]**

National Intelligence Council. *Mapping the Future*. This is the final report of the NIC's Project 2020. See http://www.cia.gov/nic/NIC_2020_project.html, 119 pages. Please read through the Executive Summary, Methodology, and Introduction (pp 9-26). Read the rest of the report as desired. The previous NIC report, *Global Trends 2015* is available at http://www.cia.gov/nic/NIC_globaltrend2015.html for those with interest (also E-reserves).

Please also go to the website of International Futures (IFs): http://www.du.edu/~bhughes/ifswelcome.html. On that website go to the Reports section. Please look at the following reports there:

Barry Hughes, "Introduction to International Futures (IFs)," 17 text pages.

Barry Hughes, "Base Case of International Futures: Comparison with Other Forecasts", 123 pages. Please read through the Introduction (pp. 1-4), Chapter 8 (pp. 106-112) and **at least one** of the issue area chapters (2 through 7), as you have interest.

The CD for IFs that you will have been given contains the model and also the Help system, with full documentation of the model. Those with laptops (not required) should install and test the software before the class session, and bring laptops to the session.

The session will involve collective interaction with and forecasting with IFs, individual interaction, and discussion of applications and limitations of the tool.

**April 11. Session 3. (1) Survey Introduction to Forecasting Techniques and (2) Your Forecasting Interests**

Humility will be a virtue throughout the course. To obtain some initially, look at "Great Moments in Forecasting" http://leeds-faculty.colorado.edu/Moyes/bplan/Misc/forecast.htm (February 26, 2006

Guest Lecturer (will change): Dr. Michael (Mickey) Glantz, former Director of the Enviornmental and Societal Impacts Group of the National Center for Atmospheric Research. Most recent book: Climate Affairs: A Primer (Island Press, 2003). Among other contents are "examples of societal uses, misuses, and potential uses of climate-related information such as forecasts."

**Deliverable 1: Forecasting Interest and Client**. Maximum of 3 pages. In order to facilitate your rapid movement into a forecasting exercise, this deliverable will identify your area of forecast interest and at least one client for it. You will have 4-5 minutes to explain the significance of your project and why the client would be interested in it, and listen to feedback from other class members. See evaluation questions 1 and 2.

**Readings**. Although there are many typologies for forecasting methods, none of which work very well, it can be argued that forecasting methods fall into four general categories: qualitative scanning and analysis, trend analysis, causal analysis, and scenario development. This and the next three sessions will each address one of these.

Robert J. Lempert, Steven W. Popper, and Steven C. Bankes. 2003. *Shaping the Next One Hundred Years: New Methods for Quantitative Long-Term Policy Analysis*. Santa Monica: The RAND Pardee Center.
Chapter 2: A History of Thinking about the Future, pp. 11-37. Available at: http://www.rand.org/publications/MR/MR1626/ February 26, 2006 E-reserves

Armstrong, J. Scott. ed. *Principles of Forecasting.*
Chapter 1 by J. Scott Armstrong. Introduction, pp. 1-12. E-Reserves

United States Commission on National Security/21st Century (the Hart-Rudman Commission). 1999ab(September 15). *The New World Coming: American Security in the 21st Century, Study Addendum*. See http://www.fas.org/man/docs/nwc/ February 26, 2006. 22 pages. E-Reserves

**Important note:** The readings listed in this and subsequent weeks include compilations of relevant chapters from the Millennium Project CD. As the course unfolds the instructors will set priorities for your reading from among these. Readings from the CD that are already known to be required are shown with an asterisk. Because your own use of forecasting techniques may vary from that of other students, the full set of chapters is listed. All other readings listed (i.e., those not on the CD) are required. This week we will begin, but not likely finish discussion of the following readings (those not discussed will be carried over to the next week):

Jerome C. Glenn and Theodore J. Gordon, eds. *Futures Research Methodology*.
*Chapter 1 by Jerome Glenn. Introduction to Futures Research Methods Series, pp. 1-17 (quickly skim the annotated bibliography, pp. 19-61).
*Chapter 3 by Theodore Gordon. The Delphi Method.
*Chapter 4 by Jerome Glenn. The Futures Wheel
*Chapter 12 by Futures Group International. Relevance Tree and Morphological Analysis
*Chapter 14 by Jerome Glenn. Participatory Methods. Skim or read lightly.
*Chapter 16 by Jerome Glenn. Genius Forecasting, Intuition, and Vision. Read through p. 10 and skim thereafter.
*Chapter 17 by Joseph F. Coates. Normative Forecasting. Read through p. 14; skim or read pp. 17-33 per your interest.

*Chapter 18 by Theodore Gordon. Science and Technology Road Mapping, read lightly.
*Chapter 20 by Alan Porter. Text Mining for Technological Foresight, read lightly.

**April 18. Session 4. Largely Qualitative Methods (Heavy on Environmental Scanning Techniques and Expert Judgment)**

**Some likely carry-over from Session 3**. Discussions of Readings and Deliverable 1

Herman Kahn, et al., *The Next 200 Years*. New York: William Morrow and Company, 1976.
Chapter 8. From Present to Future: The Problems of Transition to a Postindustrial Society, pp. 181-207. E-Reserves

Peter Schwarz, *Inevitable Surprises*. New York: Gotham Books, 2003.
Chapter 9. Inevitable Surprises, pp. 217-236. E-Reserves

James A. Dewar. 2003. The Importance of "Wild Card" Scenarios.
Unpublished RAND paper for Project 2020. 9 pages. E Reserves.

**Possible Additional Materials of Interest (not required):**

Armstrong, J. Scott. ed. *Principles of Forecasting.*
Chapter 2 by J. Scott Armstrong. Role Playing
Chapter 3 by Vicki Morwitz. Intentions
Chapter 4 by various auhors. Expert Opinions.
Chapter 5 by Dick Wittnik. Forecasting with Conjoint Analysis.
Chapter 6 by J. Scott Armstrong. Judgmental Bootstrapping.
Chapter 10 by Fred Collopy and others. Expert Systems for Forecasting.

**April 25. Session 5. Time Series and Trends (with Econometrics, other Quantitative Approaches)**

Guest Lecturer (confirmed): Dr. Paul K. Freeman (also JD), founder of ERIC Group and former participant in public/private partnership with IIASA on natural disaster risk and impact on economic performance. Consultant with World Bank on similar issues. Co-author of "Infrastructure in Developing and Transition Countries: Risk and Protection," *Risk Analysis* 23, 3 (June 2003).

"Living Dangerously: A Survey of Risk," special section in *The Economist*, January 24, 2004: 3:16. E-Reserves

**Deliverable 2: Review of existing/related analyses and forecasts**. Maximum of 8 pages. This deliverable is, in essence, a literature review. But you should have a clear eye towards identifying (1) the character of forecasts that might exist and the range of them, (2) the methodologies used, and (3) the strengths and weaknesses of work that has been done. Your intention is to go beyond previous work, so identify clearly where progress might be made. You will have a maximum of 5 minutes to sketch your review and obtain feedback from other class members. See evaluation questions 3 and 4. (Feel free to attach 1-2 additional pages with some preliminary thoughts on your own methodology in order to get my feedback – not required.)

Jerome C. Glenn and Theodore J. Gordon, eds. *Futures Research Methodology*.
Chapter 5 by Theodore Gordon. Trend Impact Analysis
Chapter 10 by The Futures Group International. Statistical Modeling: From Time Series to Simulation
Chapter 22 by Theodore Gordon. State of the Future Index (SOFI) Method

Armstrong, J. Scott. ed. *Principles of Forecasting.*
Chapter 8 by J. Scott Armstrong. Extrapolation for Time-Series and Cross-Sectional Data, pp. 217-243. E-Reserves

Robert U. Ayres. *Technological Forecasting and Long-Range Planning*. New York: McGraw Hill, 1969. E-Reserves
Chapter 4. Context: Dimensions of Technological Change. Pp. 46-71.

Prior to this class session, you will be given information about one ore more stat packages that are widely available and asked to prepare your laptop for in-class discussion of them. They will include the statistics features of Excel (including Linest). (go to Tools-Add Ins and select Analysis ToolPak) and free econometrics software called EasyReg for **Easy Reg**ression analysis:
http://econ.la.psu.edu/~hbierens/EASYREG.HTM The software is available to download at http://econ.la.psu.edu/~hbierens/ERIDOWNL.HTM (February 26, 2006)

**Possible Additional Materials of Interest:**

Armstrong, J. Scott. ed. *Principles of Forecasting.*
Chapter 7 by George Duncan. Forecasting Analagous Time Series
Chapter 8b by William Remus. Neural Networks for Time-Series Forecasting
Chapter 11 by P. Geoffrey Allen and Robert Fildes. Econometric Forecasting.

**May 2. Session 6. Causal Dynamics and Modeling**

Guest Lecturer (confirmed): Dr. Tucker Hart Adams. President and CEO, The Adams Group, which provides "research, analysis and forecasts throughout the Mountain West." Chief Economist of US Bank. Former Vice President and Chief Economist, United Banks of Colorado.

Ventana Systems. *Systems Dynamics Methods: A Quick Introduction*.
http://www.public.asu.edu/~kirkwood/sysdyn/SDIntro/SDIntro.htm [February 26, 2006]. E-Reserves
Chapter 1: System Behavior and Causal Loop Diagrams, pp. 1-14.

Jerome C. Glenn and Theodore J. Gordon, eds. *Futures Research Methodology*.
Chapter 6 by Theodore Gordon. Cross-Impact Analysis
Chapter 8 by Allenna Leonard with Stafford Beer. The Systems Perspective: Methods and Models for the Future
Chapter 15 by Erwin Rausch. Simulation and Games in Futuring and Other Uses.
Chapter 21 by Theodore Gordon. Agent Modeling.

Donella Meadows, et al. *The Limits to Growth*. New York: New American Library, 1972.
Chapter 3. Growth in the World System, pp. 88-128. E-Reserves
Will probably substitute Chapter 4 The Dynamics of Growth in a Finite World from *Limits to Growth: The 30-Year Update* White River Junction, Vermont: Chelsea Green Publishing Co, pp. 129-179.

Cameron Hepburn, Long-run Discounting. 2002 (September). *Utilities Journal*.
http://www.economics.ox.ac.uk/members/cameron.hepburn/longrundiscounting.pdf; February 26, 2006. 3 pages E-Reserves

Prior to this class session, the students with laptops are urged to go the website of Vensim, a leading producer of systems dynamics software, for free download of a trial version of Vensim. Go to: http://www.vensim.com/ and http://www.vensim.com/freedownload.html [February 26, 2006]

See also a site developed by Craig Kirkwood at Arizona State University devoted to systems dynamics: http://www.public.asu.edu/~kirkwood/sysdyn/SDRes.htm. At that site you will find links to many Vensim related resources, including a tutorial at http://www.public.asu.edu/~kirkwood/sysdyn/VenPLE.pdf [February 26, 2006] E-Reserves

We will explore the use of Vensim during the class session.

**May 9. Session 7. Scenario Analysis**

**Deliverable 3: Plan for your own forecast.** Maximum of 15 pages. This deliverable adds a methodological statement to your earlier statements of client and interests, forecast intention, and literature review. It should be appropriate for your interest area, doable, and have promise to add value to previous work in your area. You will have a maximum of 5 minutes to sketch your plan and obtain feedback from other class members. See evaluation questions through 7.

Pierre Wack. 1985 (September-October). "Scenarios: Uncharted Waters Ahead," *Harvard Business Review*, pp. 73-89. This and the other Wack article are available on-line through Penrose. Use Database and Article Search, alphabetically list All databases, select Business Source Premier, which will lead you to the articles, enter Wack in author field and Scenarios in title field, for access to .pdf of full text. E-reserves

Pierre Wack. 1985 (November-December). "Scenarios: Shooting the Rapids," *Harvard Business Review,* pp. 139-150. E-reserves

Peter Schwarz. 1991. *The Art of the Long View*. New York: Doubleday. This is not required reading because it repeats a considerable amount of what Wack said in the articles above. It is recommended for those who intend to develop their own scenarios. E-Reserves.

The Pathfinder's Tale, pp. 3-15
Uncovering the Decision, pp. 44-59.
Creating Scenario Building Blocks, pp. 100-117.
Composing a Plot, pp. 135-162.

International Energy Agency. 2003. *Energy to 2050: Scenarios for a Sustainable Future* Paris: IEA. See http://www.iea.org/textbase/nppdf/free/2000/2050_2003.pdf February 26, 2006.
Background, pp. 13-18
Chapter 1. Long Term Energy and Environment Scenarios: The Literature, pp. 19-55 (can skim 34-55). E-reserves

Millennium Project Scenario Development for peace in the Middle East. See http://www.acunu.org/millennium/MEPS-rd3.doc; February 26, 2006. E-reserves. This strongly normative scenario set for the Middle East is a collective, iterative effort involving people across religious/cultural backgrounds; it is not so much a forecast as a political activity.

**Possible Additional Materials of Interest:**

Armstrong, J. Scott. ed. *Principles of Forecasting.*
Chapter 20 by J. Scott Armstrong. Standards and Practices for Forecasting, pp. 679-728. This is a very comprehensive overview/analysis of principles of forecasting. E-Reserves

Allen Hammond. 1998. *Which World? Scenarios for the 21st Century*. Washington: World Resources Inc.
Chapters 3-5, pp. 26-61. E-reserves

Jerome C. Glenn and Theodore J. Gordon, eds. *Futures Research Methodology*.
Chapter 7 by Jacques Arcade and others. Structural Analysis with the MICMAC method
Chapter 13 by Jerome Glenn. Scenarios
Chapter 13.5 by Theodore Gordon. Interactive Scenarios.
Chapter 25 by Michel Godet. A Tool-Box for Scenario Planning

Robert J. Lempert, Steven W. Popper, and Steven C. Bankes. 2003. *Shaping the Next One Hundred Years: New Methods for Quantitative Long-Term Policy Analysis*. Santa Monica: The RAND Pardee Center. Available at: http://www.rand.org/publications/MR/MR1626/
Chapter 4: A Framework for Scenario Generation, pp. 69-85. E-reserves

Dale S. Rothman, "Environmental Scenarios: A Survey," unpublished manuscript. E-reserves

**May 16. Session 8. Forecasting at Work 1: Selecting and Combining Methods (Socio-Political Forecasts)**

Jerome C. Glenn and Theodore J. Gordon, eds. *Futures Research Methodology*.
Chapter 27 by Theodore Gordon and Jerome Glenn. Integration, Comparisons, and Frontiers of Futures Research Methods.

United States Commission on National Security/21st Century (the Hart-Rudman Commission). 1999a (September 15). *The New World Coming: American Security in the 21st Century, Supporting Research and Analysis*. See http://www.fas.org/man/docs/nwc/ ; February 26, 2006. E-reserves. Those with no interest can read the NWC Summary version, but it is not nearly as useful. Both on E-reserves

Raskin, Paul, et al. 2000. *Great Transition: The Promise and Lure of the Times Ahead*. Boston: Stockholm Environment Institute, 2002. See http://www.tellus.org/seib/publications/Great_Transitions.pdf; February 26, 2006. E-reserves

Beginning with this session, we may have a small number of volunteers discuss their full projects, including forecasts.

**Possible Additional Materials of Interest:**

Armstrong, J. Scott. ed. *Principles of Forecasting.*
Chapter 12 by J. Scott Armstrong. Selecting Methods

Chapter 13 in three parts by many.
Judgmental Time-Series Forecasting Using Domain Knowledge.
Judgmental Adjustment of Statistical Forecasts
Combining Forecasts

**May 23. Session 9. Forecasting at Work 2: Selecting and Combining Methods (Energy-Environmental Forecasts)**

Guest Lecturer: Mr. Thomas Frey, Executive Director, the DaVinci Institute. Forecasting technological change is one of the most difficult of all forecasting. We will hear how this institute thinks about it.

Shell International (2005, updating work of 1995 and 2001). Shell Global Scenarios to 2025 Executive Summary .pdf at www.shell.com/scenarios February 26, 2006; 24 pages. Some of you may be interested (not required) in the 2001 scenarios: Energy Needs, Choices and Possibilities: Scenarios to 2050. See http://www.cleanenergystates.org/CaseStudies/Shell_2050.pdf ; February 26, 2006, 33 pages. E-reserves

United Nations Environmental Programme (UNEP). 2002. *Global Environment Outlook (GEO)*. United Nations: EarthScan Earth Summit. http://www.unep.org/geo/; February 26, 2006.Chapter 4. Outlook 2002-32, pp. 320-400. E-reserves

**May 30. Session 10. Wrap-up and Debriefing**

**Deliverable 4: Provide forecast results and explanation, commentary.** No written report, presentation only. This deliverable is a report to the class on your forecasting work, with a sketch of alternative scenarios or analysis of possible forecast errors.. Although you should expect that you will do some light further work and revision after your presentation, you should have definite results at this stage and be largely finished with your final written report. . You will have a maximum of 7 minutes to sketch your results and obtain feedback from other class members. See evaluation questions 8, 9, and 10 (with a very quick reference back in presentation to earlier questions, as appropriate).

Debriefing. We will collectively review the elements of the course and analyze their strengths and weaknesses. How could you learn more about the art of forecasting?

**Deliverable 5: Final Written Report. Due by 4:30 PM, June 2.** See the requirements for the final report at the beginning of the syllabus. See all evaluation questions.

UNIVERSITY OF DENVER GRADUATE SCHOOL OF INTERNATIONAL STUDIES

# The Art of Forecasting

*Evaluation of Final Paper*

**Name**
**Title**

1. Is the topic clearly defined and introduced? Is the logic of presentation made clear to the reader via an abstract, overview, and/or table of contents?

2. Is the motivation for the forecast well presented? That is, is the importance of the forecasted variable(s) discussed in terms of policy/decision issues linked to it or in terms of the significance of it in its own right?

3. Is what is being forecasted clearly conceptualized and presented? If the variable(s) are quantitative, is a measure offered? If they are not quantitative, is a schema presented?

4. Are other forecasts of the variable(s) described and analyzed in a manner that can assist with the current analysis? Was there broader environmental scanning for significant drivers, events, wild cards, weak signals, etc.?

5. Are the key drivers of the forecasted variable(s) clearly specified (verbally or in a causal diagram)? Is the set given justified theoretically or in terms of literature/argument? Are the drivers identified given adequate discussion and are their own forecasts/extrapolations meaningful?

6. Are the levers for intervention identified as a subset of drivers or independently?

7. Is the methodology (or combination of methodologies) clear and appropriately chosen? Were they well applied?

8. Are alternative scenarios introduced (with reasonable names and descriptions) and are they convincing? Do the scenarios seem to adequately explore the space of uncertainty around the forecast (for instance, via specification of key elements/dimensions of uncertainty)? If scenarios are not used, is some other technique for mapping uncertainty used? Do the scenarios deal appropriately with wild cards/surprises?

9. Overall, is the forecast clearly and convincingly presented? In case of scenarios, is there any probability assignment or explanation of circumstances/policy decisions that might tilt system towards or away from each?

10. Does the paper contain a discussion linking forecasts/scenarios back to the motivation for it? If the motivations involve policy issues, are recommendations made?

11. Is the paper technically sound in terms of organization, language use, aides to presentation (tables, graphs, etc), pagination, readability, bibliography and citations, etc.?

12. Additional comments and overall feedback.

Grade of Final Report: