

Paul J. Werbos

To email me, the username is just my last name, and the host is ieee dot org.

Employment

2009: Brookings Institution: Legislative Fellow

Worked in Office of Senator Specter, still an NSF employee. Primary assignment involved science, economics and technology related to climate change, energy, space and defense technology, in that order.

1989-2013: Research Program Director, Engineering Directorate, National Science

Foundation In every technical area I manage, I am responsible for knowing the technical details and challenges in the most advanced current research, informing the research community of the opportunities, running technical review panels, and deciding which research proposals to fund. This gives a unique opportunity to ask questions and see the gap between global policies and what happens at the ground level.

From 1989-2013, **I have led the area of Adaptive and Intelligent Systems (AIS)**. AIS develops new general-purpose designs for distributed intelligence, in order to predict or manage systems on any scale from nanorobots to electric power grids. Success stories so far include applications to car engines, airplanes, turbogenerators, electric power quality, heating and cooling of buildings, dextrous robots, missile interception, preventing crashes of damaged aircraft, and some biomedical systems.

From 2011-2013, have coordinated the interagency Academic Research Initiative on nuclear detection and terrorism.

Other areas I have created and led:

2005-2013: **Quantum, Molecular and High Performance Modeling and Simulation** for Systems and Devices (QMHP). QMHP brings together leaders in quantum engineering and quantum theory, in algorithms for high-performance computing, and in advanced concepts for electronic systems. It supports crossdisciplinary efforts to create entire new classes of systems and devices.

2007-2008: Cognitive Optimization and Prediction (COPN). COPN funds teams of neuroscientists and engineers to work together, to **“reverse engineer” how the brain learns** to predict its environment and to do better and better in coping with it.

2002: Joint Investigation of Enabling Technologies for **Space Solar Power** (JIETSSP, joint with NASA and the Electric Power Research Institute).

1994-(1998): Enabling Technologies for **Fuel Cell and Electric Vehicles** (a small business research topic).

Have also led cross-disciplinary technologies for sustainability (2008), cyber systems, electric power grid research, wireless communications, and emerging technologies initiation. Was an active team member in cross-cutting activities in Learning and Intelligent Systems, Information Technology Research, the Interagency Education Research Initiative, the NSF-EPA joint program on Technologies for a Sustainable Environment, Collaborative Research in Computational Neuroscience, and Hydrocarbons from Biomass.

Have given many **plenary talks and tutorials**, mostly at conference expense (approved by NSF), in the US, China, Japan, Mexico, Brazil, Canada, Finland, Chile, Korea, England, Greece, Singapore, Belgium, Germany and Portugal.

1979-1989: Modeling, Analysis and Forecasting, at the Energy Information

Administration, DOE. At Office of Energy Information Validation, was responsible for evaluating all aspects of EIA’s long-term energy forecasting model, and comparing it with the lead models elsewhere (like the DOE Policy Office.) Duties ranged from deciphering FORTRAN code, to find out and explain

what was really in the models, through to assessing technology input assumptions, econometrics, sensitivity analysis and formal analysis.

Next became **lead analyst for the long-term future**. Built new official EIA models for industrial energy demand, transportation energy demand and oil/gas. Used my new mathematical tools to fit the oil/gas model on a self-documenting spreadsheet, without reduction in accuracy. Proposed, designed and wrote up the first carbon tax scenario for the Annual Report to Congress (now Annual Energy Outlook).

Managed contracts at Oak Ridge, MIT, RAND Corporation, Chase Econometrics and Harvard.

1978-1979: Rotator at Census Use Research (CUR), Census Bureau.

CUR was an in-house research group at the Census Bureau, based on the unique resource of full access to raw Census data. Reviewed over 50 regional economic forecasting models. Developed plans for how to use Census data to get a more accurate **regional economic forecasting system**, and use it in optimal allocation of billions of dollars worth of urban and agricultural development funds Census was tasked to address.

1975-1978: Assistant Professor in Public Policy, University of Maryland.

Taught graduate courses in quantitative methods, and courses in “global survival problems” (the politics of sustainability). Co-investigator of DARPA grant on crisis warning and conflict prediction.

1973-1975: Statistical Programming for Harvard MIT “Project Cambridge”

Built new analysis commands for the MIT Time-Series Processor econometric package and for a new “Consistent System” package for social science research.

Prior to 1973:

I worked as a teaching assistant and a lab instructor at Harvard, and as a consultant or summer employee at the RAND Corporation, at the Center for Research in Conflict Resolution, at Abt Associates, at the Bendix Office of National Security Studies, and at the cardiac research group at Jefferson Hospital in Philadelphia.

Education

1974: Ph.D., Harvard, Committee on Applied Mathematics. Developed new mathematical tools and used them to enable new statistical forecasting methods. Showed how these new methods give accurate hundred-year forecasts with Karl Deutsch’s model of *Nationalism and Social Communications*, and greater accuracy both in a more fine-grained model and in simulated time-series. Thesis reprinted in my book *The Roots of Backpropagation: From Ordered Derivatives to Neural Networks and Political Forecasting*, Wiley, 1994.

(1972): S.M., Harvard, Committee on Applied Mathematics. Major in quantum physics. Minors in decision and control and in mathematical methods.

1968: M.Sc., London School of Economics. International Political Systems with emphasis on EU.

1967: B.A., Harvard, Magna Cum laude, Economics.

1964 and before: Credit for 5 full-year courses in mathematics at junior undergraduate level or higher at Princeton and the University of Pennsylvania, while in high school at Chestnut Hill Academy (Phila.) and Lawrenceville School (New Jersey). FCC First Class Commercial Radiotelephone License at age 14.

Volunteer Activities

Energy policy: Active member of the **IEEE Energy Policy Committee** (EPC), representing the IEEE Computational Intelligence Society (CIS), for > 10 years. Initiated and wrote the first draft of the white paper on plug-in hybrid cars. Helped organize the follow-on conference in DC. Have given numerous talks at Rayburn and elsewhere for EPC, as well as for the Set America Free coalition (www.setamericafree.org). Organized and led the Task Force on Alternate Energy of CIS, with members ranging from key engineers at GM and Toyota and GE through to the Chinese Academy of Sciences and the University of Chile. .

Global Futures: Serve on the Planning Committee of the Millennium Project, the UN-related international organization which produces the **State of the Future** (www.stateofthefuture.org), the most widely used international report giving an integrated analysis of the future challenges facing humanity. At their invitation, gave 3 talks at the World Public Forum 2008, to improve international dialogue. Contributed to activities of the National Space Society and Foundation for the Future. In 1990's, elected regional director of the L-5 Society, guiding chapters from New Jersey to Georgia, and writing occasion position papers. Active member of IEEE Transportation and Aerospace Policy Committee; wrote a new position paper on access to space which has passed committee and is under higher level approval cycle.

Scientific: Past President and Fellow of the International Neural Network Society. Have served on the governing boards of the IEEE Computational Intelligence Society, the society for Systems, Man and Cybernetics, and Industrial Electronics. Fellow of the IEEE. Won the IEEE Neural Network Pioneer Award for developing fundamental algorithms responsible for revival of neural networks in 1986, and for the new emergence of approximate and adaptive dynamic programming (ADP). Have about 10 patents, assigned to companies partly owned by my wife for which I have no shares or responsibility. Some of my ADP designs are ways to calculate what economists call "shadow prices," the correct prices to use when the future is uncertain.

Miscellany

Born September 4, 1947, in Philadelphia suburbs. Married, four children. Selected publications and talks posted at www.werbos.com, organized by topic. Virginia resident since 1998. Independent. Quaker. 33 pages worth of publications listed on google scholar; many posted at www.werbos.com (though not the ten last year).