

Drug Discovery Approach to Breakthroughs in Batteries

September 8th and 9th, 2008
Massachusetts Institute of Technology
Cambridge, Massachusetts

Participants



George Adamson, Vice President of Product Development, ZPower, Inc.

Dr. Adamson leads ZPower's intellectual property development and oversees a technical team advancing silver-zinc battery chemistry for mobile electronics applications. Prior to joining ZPower, Dr. Adamson was the head of Virtic, LLC, where he directed the company's contract engineering and scientific consulting services. He was also the vice president of research and development at Valence Technology Corporation, a firm developing and manufacturing lithium polymer batteries, where he was responsible for setting the company's strategy for its intellectual property portfolio and launched the company's first three mass-produced product lines. Dr. Adamson was also the senior research scientist for Zinc Air Power Corporation, a start-up company developing a commercial electric vehicle battery. In this position, Dr. Adamson directed an electrochemical research and catalyst testing program to develop a commercial bi-function air cathode.

Educational background:

B.S. Chemistry, University of California, Riverside, 1988; Ph.D. Physical Chemistry, Massachusetts Institute of Technology, 1994

George Blomgren, Chief Scientist, Lion Cells

Dr. George E. Blomgren evolved from a theoretical chemist into a battery expert, first by earning a B.S. in chemistry from Northwestern University in 1952 and a Ph.D. in physical chemistry from the University of Washington in 1956. After a post-doc at Columbia University, he began a 41-year career with Union Carbide Corp. which evolved into the Eveready Battery Co. His early work with UCC involved statistical mechanical theories of liquids, electrolyte solutions, and molten salts. This led to a group leader position in the Battery Products Division in 1963 with a focus on the then-new lithium batteries. His work on electrolytes prepared the way in 1971 to filing the first patent on lithium liquid cathode batteries in which the liquid (e.g., thionyl chloride) serves as both the solvent for the electrolyte salt and the active cathode material. This dual role allows very high energy to be packed in the container, thus forming the highest energy primary battery in use today. His work also led to the lithium-ion disulfide battery, which the company developed into a commercial product, first as a button cell and then as an AA and AAA cell. His reward was the highest technical position at Eveready - Senior Technology Fellow.

After retirement he started a new career consulting with companies around the world on battery technology and applications. He also has presented invited papers at many meetings in the U.S., Europe, and Asia to the delight of his wife Gerry, who is always ready to pack up and go with him. George was Associate Editor of the Journal of the Electrochemical Society, Chair of the ECS Battery Division, and adjunct professor at Carnegie Mellon universities. He continues as adjunct professor at Case Western Reserve University in the Department of Chemical Engineering. With the formation of the new company "Lion Cells, Inc.", George became a founder and the Chief Scientist in 2006.

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Ralph J. Brodd, President, Broddarp of Nevada, Inc.

Ralph J. Brodd is President of Broddarp of Nevada, Inc., a consulting firm specializing in technology assessment, strategic planning and battery technology, production, and marketing. He received a B.A. degree in chemistry from Augustana College, Rock Island, Illinois, and M.A. and Ph.D. degrees in physical chemistry from the University of Texas at Austin.

Dr. Brodd began his career at the National Bureau of Standards in Washington, D.C., studying electrode reactions and phenomena that occur in battery operation. He taught physical chemistry in the U.S. Department of Agriculture Graduate School and lectured in electrochemistry at Georgetown University and American University.

In the 1960s and 1970s, Dr. Brodd served in a variety of technical and management capacities with a number of battery companies. In 1961, Dr. Brodd joined the L.T.V. research Center of Ling Temco Vought, Inc., in Dallas, Texas, where he established a group in fuel cells and batteries. In 1963, he moved to the Battery Products Technology Center of Union Carbide Corporation, with technical management responsibilities for nickel-cadmium and lead acid rechargeable batteries, alkaline and carbon-zinc product lines, and exploratory R&D. He joined ESB (INCO Electroenergy, Inc.) in 1978, establishing a technology surveillance group, and moving to the position of Director of Technology with oversight and policy responsibility for R&D laboratories serving product areas ranging from primary and secondary batteries to uninterruptible power supplies and small electric motors. He was a member of the INCO Long Range Technology Committee and the technical advisory panel for North America Capital Venture Fund.

In 1982, Dr. Brodd established Broddarp, Inc., a consulting firm specializing in battery technology, strategic planning, and technology planning. A consultancy with Amoco led to his moving to Amoco Research Center as project manager of a rechargeable lithium sulfur dioxide battery project. He subsequently moved to Gould, Inc., to establish their Lithium Powerdex Battery Venture and then to Valence Technology, a venture group developing a solid polymer electrolyte battery system for rechargeable batteries for portable consumer devices. He served as staff consultant/marketing director and then Vice President, Marketing.

Dr. Brodd was elected President of The Electrochemical Society in 1981 and Honorary Member in 1987. He was elected National Secretary of the International Society of Electrochemistry, 1977-1982, and Vice President, 1981-1983. He is past chairman of the Board of Directors of the International Battery Materials Association. Dr. Brodd has over 100 publications and patents.



Valerie Browning, ValTech Solutions, LLC

Valerie Browning is an independent consultant and subject matter expert for ValTech Solutions, LLC. She serves as a subject matter expert for a number of DoD and other government activities in the areas of advanced materials and alternative energy.

Prior to forming ValTech Solutions, LLC in December 2007, Dr. Browning served as a Program Manager in the Defense Sciences Office at the Defense Advanced Research Program Agency. During her tenure at DARPA, she assumed full responsibility for the strategic planning, operating management, leadership and development of multiple R&D programs providing innovative technologies in power and energy, radar, telecommunications, and biotechnology for diagnostics, therapeutics and chem./bio warfare defense. She also served as the DARPA liaison to the DoD IPT on Energy Security and served as Acting DSO Office Director prior to her departure from government service. In addition to her time at DARPA, Dr. Browning spent 16 of her 24 years of government service as a research physicist at the Naval Research Laboratory. Her primary areas of research were thermoelectric materials, high temperature superconductors and magnetic oxide materials. She has published over 40 peer review manuscripts including three book chapters.

Born in South Ruislip, England, Valerie is a 1987 graduate of Virginia Tech where she received her B.S. in physics. She also holds a M.S. in physics from the University of Maryland and a Ph.D. in physics from the Catholic University of America.



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James Caruthers, Professor of Chemical Engineering, Purdue University

Director, Center of Integrated Materials and Product Design (CIMProD)
S.B.(Chem) Massachusetts Institute of Technology, 1975
S.M. Massachusetts Institute of Technology, 1976
Ph.D Massachusetts Institute of Technology, 1977



Professor Caruthers' aim is to develop models to describe the behavior of a variety of chemical, polymeric and biological systems. His research interests include the design of formulated rubbers, the nonlinear mechanical behavior of glassy polymers, the rational design methods for catalysts, and the origins of the glass transition.

The modeling of these complex systems requires the analysis of large amounts of data, which includes high throughput experimentation (HTE) and high throughput computations (HTC) as well as high throughput modeling tools to keep pace with data flow. In order to support these various research projects Caruthers leads a team that includes chemists, engineers and computer scientists/engineers that is developing an integrated discovery environment that includes data ingress, data storage and retrieval using domain specific ontologies, data analysis and modeling, and rich visualization that using domain specific images.

Gerbrand Ceder, R. P. Simmons Professor of Materials Science & Engineering, MIT

Gerbrand Ceder received an engineering degree in Metallurgy and Applied Materials Science from the University of Leuven, Belgium, in 1988, and a Ph.D. in Materials Science from the University of California at Berkeley in 1991 at which time he joined the MIT faculty. Dr. Ceder's research interests lie in computational modeling of material properties and the design of novel materials. Currently, much of the focus of his work is on materials for energy generation and storage, including battery materials, hydrogen storage, thermoelectrics, and electrodes and electrolytes for fuel cells. He has published over 210 scientific papers in the fields of alloy theory, oxide phase stability, high-temperature superconductors, and Li-battery materials, and holds 5 current or pending U.S. patents. He has received the Battery Research Award from the Electrochemical Society, the Career Award from the National Science Foundation, and the Robert Lansing Hardy Award from The Metals, Minerals and Materials Society for "exceptional promise for a successful career." He has also received three awards from the graduate students at MIT for best teaching. As a faculty member at MIT he has been involved with distance education offering a course on Atomistic Modeling life over the internet. He is currently a group leader for the Research Program on High Performance Power Sources in the Center for Materials Science and Engineering. At MIT he has served on the Committee on Intellectual Property and on MIT's Presidential Council on Energy. He is the founder of Computational Modeling Consultants.



W. Nicholas Delgass, Maxine Spencer Nichols Professor of Chemical Engineering, Purdue University

B.S. University of Michigan, 1964
M.S. Stanford University, 1966
Ph.D Stanford University, 1969



The goal of Professor Delgass' research in heterogeneous catalysis is to understand the surface chemical origins of catalytic activity and to use that fundamental knowledge in a process called Discovery Informatics for the design of catalysts. Steady state reaction and transient isotopic tracing provide quantitative chemical kinetic evaluation of catalytic performance, while spectroscopic measurements yield details of the chemistry of catalytic surfaces. X-Ray photoelectron spectroscopy gives a quantitative chemical analysis of catalyst surfaces prepared in situ. Solid state NMR and infrared spectroscopy reveal further details of the chemical state of the surface and the bonding of adsorbed species. Discovery Informatics is a framework that enables management of complexity, accumulation of knowledge, systematic testing of hypotheses by interaction with experiments, and the efficient search for new materials with desired performance characteristics. Six chemical engineering professors at Purdue have teamed together to apply this methodology to catalyst design. The approach uses high throughput experiments and quantum level theory to gain information on catalyst performance and chemistry and then uses a variety of systems tools to guide and execute building models that capture catalytic knowledge and discover new catalysts. Current areas of research interest include the water gas shift reaction, NOx traps, olefin polymerization, and biomass conversion.

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Ernst Dow, Group Leader, Discovery Informatics, Eli Lilly and Company

After receiving his B.S. in Chemistry with a Computer Science option from the University of Pittsburgh in 1988, Dr. Dow joined Eli Lilly and Company focusing on computational chemistry. Following an AI Fellowship with Digital Equipment Corporation in neural networks he worked on QSAR and then took an educational leave, obtaining his Ph.D. from the University of Illinois at Urbana-Champaign in Biophysics and Computational Biology under Dr. Thomas Anastasio in 1999. He has been in Bioinformatics leading the effort to gain insight into biology from microarray and other high information content studies. His current focus is integrating information from many sources to allow a scientific question driven approach to access the proper data.

L. Louis Hegedus, Ret. Sr. VP R&D, Arkema

L. Louis Hegedus, Ph.D., retired in 2006 as senior vice president of research and development for Arkema Inc., a \$8-billion global chemical company headquartered in Paris, France. Dr. Hegedus was responsible for all research and development in North America and R&D coordination between the U.S. & France. Arkema is a major manufacturer of plastics and specialty and performance chemicals. Prior to joining the company in 1996, Dr. Hegedus was vice president of the corporate technical group of W.R. Grace. His 16 years of experience with that company included positions as director of inorganic research & vice president of research for the company's specialty chemicals businesses.



Prior to joining W.R. Grace, Dr. Hegedus was affiliated with the General Motors Research Laboratories, where he managed research on the development of the catalytic converter for automobile emissions control. His previous employment with Daimler Benz AG in Mannheim, Germany, as group leader in the materials testing department, was followed by attendance at the University of California, Berkeley, from which he received his Ph.D. in chemical engineering. His earlier education was completed at the Technical University of Budapest, where he obtained his M.S. in chemical engineering.

Dr. Hegedus has over 75 publications and patents, mainly in chemical reaction engineering and industrial catalysis as applied to chemicals, petroleum, emission control, and energy conversion. His honors include the Catalysis and Reaction Engineering Practice Award, the Management Division Award, the R. H. Wilhelm Award, and the Professional Progress Award of the American Institute of Chemical Engineers (AIChE), and an honorary Doctor of Engineering from the Technical University of Budapest. He is a fellow of the AIChE, a member of the National Academy of Engineering (NAE), a past chairman of the NAE's Chemical Engineering Section, and a past chairman of the Council for Chemical Research. As a member of the Board on Chemical Sciences and Technology, he chaired the National Research Council's Report on Critical Chemical Technologies. Dr. Hegedus is a past or present member of a number of editorial boards (including Chemical and Engineering News, AIChE Journal, Ullmann's Encyclopedia of Technical Chemistry, Catalysis Letters), and academic advisory boards (including Berkeley, Princeton, Wisconsin, and UCLA). Dr. Hegedus has recently served on a National Research Council committee which benchmarked US chemical engineering research against the rest of the world, and on a National Science Foundation committee on nanotechnology. Since 2006, he has been a consultant to the chemical and related industries.

Lonnie Johnson, Founder and President, Excellatron



Lonnie Johnson is President and Founder of Johnson Research & Development Co., Inc., a technology development company, and its spin-off companies, Excellatron Solid State, LLC, and Johnson Electro Mechanical Systems, LLC. Johnson holds a B.S. degree in Mechanical Engineering, an M.S. degree in Nuclear Engineering, and an honorary Ph.D. in Science from Tuskegee University. Upon graduation, he joined the Air Force and served as an Advanced Space Systems Requirements Officer at Strategic Air Command headquarters. He was twice awarded the Air Force Achievement Medal and the Air Force Commendation Medal. After leaving the military, he joined the Jet Propulsion Laboratory (JPL) in California. During his nine year career with JPL, he received multiple achievement awards from NASA for his work in spacecraft system design for the Galileo Mission to Jupiter and the Mars Observer projects, and was instrumental in the Cassini Mission to Saturn.

In 1989, he formed his own engineering firm and licensed his most famous invention, the SuperSoaker® water gun, to Larami Corporation. Two years later, the SuperSoaker, which has generated over \$1 billion in retail sales, became the number one selling toy in America. Currently, Lonnie Johnson holds over 100 patents, with over 20 more pending, and is the author of several publications on spacecraft power systems. Johnson's companies, Excellatron Solid State and Johnson Electro Mechanical Systems (JEMS), are developing revolutionary energy technology.

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A. Refik Kortan, Program Manager for Physical Behavior of Materials, Materials Sciences and Engineering Division, Office of Basic Energy Sciences, Department of Energy



M.S. in Physics, University of Maryland, 1976
Ph.D. in Physics, University of Maryland, 1979

Dr. Refik Kortan earned his Ph.D. degree in surface physics from University of Maryland in 1979. He was a post-doctoral fellow at the Physics Department in MIT before he joined then AT&T Bell Laboratories in 1984. Dr. Kortan utilized high-resolution x-ray scattering to study novel phase transitions in reduced dimensions, liquid crystals, and graphite intercalation compounds while he was at MIT. During his 20 years stay at Bell Labs, Dr. Kortan has received numerous AT&T Exceptional Contribution Awards. He has published over 200 papers, presented 182 invited and contributed talks, and held 13 patents. He has been recognized as one of the most cited physicists due to his pioneering research, receiving 4497 and 6947 citations during the span of 1981-1997 and 1991-2003, respectively. He was elected Fellow of the American Physical Society in 1996 for his experimental studies of phase transitions on surfaces, liquid crystals, and intercalated systems; and his work on new materials such as quasicrystals and fullerenes.

Paul McGinn, Professor of Chemical Engineering, University of Notre Dame



B.S. Metallurgical Engr. & Materials Science, University of Notre Dame (1980)
M.S. Metallurgical Engr. & Materials Science, University of Notre Dame (1983)
Ph.D. Metallurgical Engr. & Materials Science, University of Notre Dame (1984)

Professor McGinn's primary research interests are in the areas of the processing and properties of advanced materials. Current research programs are aimed at developing the processing tools and screening instrumentation for combinatorial materials development and discovery. The combinatorial approach to materials research employs parallel (or automated serial) processing to create large "libraries" of material compositions, followed by parallel (or automated serial) testing to characterize the compositions for a specific property of interest. Much of the potential of the combinatorial approach rests on the development of rapid means to screen libraries for a property of interest. Over the past several years his group has developed and put in place a wide range of automated processing and characterization tools for combinatorial research.

Dagmar Niebur, Program Director, National Science Foundation & Associate Professor of Electrical & Computer Engineering, Drexel University



Dr. Dagmar Niebur joined the National Science Foundation in March 2007 as a Program Director for the Power, Controls and Adaptive Networks (PCAN) Program of the Electrical, Communications and Cyber Systems (ECCS) Division in the Directorate for Engineering (ENG). Her responsibilities within the PCAN program include Power and Energy Systems and Networks, Renewable and Alternate Energy Sources: Generation and Integration into the National Grid, and Interdependencies of Critical Infrastructures in Power.

Dr. Niebur is on an IPA assignment from Drexel University, where she is an Associate Professor and the Assistant Department Head of Planning and Development in the Department of Electrical and Computer Engineering. Before joining the faculty at Drexel, she held research positions at the Jet Propulsion Laboratory, Pasadena, CA; the Swiss Federal Institute of Technology, Lausanne, Switzerland; the University of Lausanne; and was a summer Visiting Professor at CEPTEL, Rio de Janeiro, Brazil. Dagmar Niebur holds a Diploma in Mathematics and Physics from the University of Dortmund, Germany (1984), and her Diploma in Computer Science (1987) and Ph.D. in Electrical Engineering (1994) from the Swiss Federal Institute of Technology, Lausanne, (EPFL) Switzerland.

Dr. Niebur is a member the Institute of Electrical and Electronics Engineers (IEEE), where she serves as member of the IEEE-PES Technical Council Advisory Board and chair of the IEEE-PES Subcommittees on Intelligent Systems and Research in Power Engineering Education. She is also a member of the American Society for Engineering Education, the Editorial Advisory Board of the International Journal of Engineering Intelligent Systems for Electrical Engineering and Communications, and the Board of Directors of the International Conference on Intelligent Systems for Power Systems.

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Luis Ortiz, Visiting Scientist, MIT

Luis is a Visiting Scientist focused on advanced battery technologies. An accomplished technologist, Luis has six years of experience in the battery industry serving as both an independent consultant and Program Manager for technology transfer while with Valence Technology. Prior to entering the energy sector, Luis was a Six Sigma Blackbelt in Honeywell's Electronic Materials Division. Luis holds an SB and ScD from MIT's Department of Materials Science & Engineering. Always keen to social side of learning, Luis developed a number of organizations and programs while a student which served to bring technologists and members of the business community together.



Kristin Persson, Chemist Research Scientist, Lawrence Berkeley National Laboratory

Dr Kristin Persson has been working on predicting new battery materials from ab initio computations, together with Professor Gerbrand Ceder, since 2005. She received her graduate degree in Theoretical Physics from the Royal Institute of Technology, Sweden in 2001 after which she came to MIT and held two postdoctoral associate appointments between 2001-2002 and 2004-2007. In 2008 she joined the Battery for Advanced Transportation Technologies effort at the Lawrence Berkeley Livermore Laboratory. She has co-authored 15 peer-reviewed publications.

Krishna Rajan, Stanley Chair in Interdisciplinary Engineering, Iowa State Univ.

B.A.Sc. – University of Toronto, 1974

Sc.D. – Massachusetts Institute of Technology, 1978

Krishna Rajan received his B.A.Sc. in Metallurgy and Materials Science from the University of Toronto and the ScD in Materials Science. He was also a postdoctoral fellow at MIT and Cambridge University. He served as a research scientist with the National Research Council of Canada in the 1980s after which he joined the faculty at Rensselaer Polytechnic Institute before coming to Iowa State University in 2005. He holds appointments in the Department of Materials Science & Engineering and the Bioinformatics and Computational Biology Graduate Program. He is director of the National Science Foundation's International Materials Institute for the Combinatorial Sciences and Materials Informatics Collaboratory.

Prof. Rajan has held numerous visiting appointments, including the Max Planck Institut für Metallforschung, Stuttgart, the NRC Eastern Europe Fellowship at the Slovak Academy of Sciences, and the CNRS visiting professorship at the University of Rennes in France. He serves on many national and international committees including the US National Committee on Data Science and Technology (CODATA) of the US National Academies, co-chair of the National Science Foundation Panel on Cyber Infrastructure for Materials Science, the CODATA International Task Group of Materials Data Exchange and Operability and most recently appointed delegate to the US-China Bilateral Roundtable on Scientific Data Cooperation.



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Donald R. Sadoway, John F. Elliott Professor of Materials Chemistry, MIT



B.A.Sc., Engineering Science, University of Toronto, 1972
M.A.Sc., Chemical Metallurgy, University of Toronto, 1973
Ph.D., Chemical Metallurgy, University of Toronto, 1977

Professor Sadoway's research seeks to establish the scientific underpinnings for technologies that make efficient use of energy and natural resources in an environmentally sound manner. This spans engineering applications and the supportive fundamental science. The overarching theme of his work is electrochemistry in nonaqueous media.

Specific topics in applied research are the following: environmentally sound electrochemical extraction and recycling of metals, lithium solid-polymer-electrolyte batteries for portable power, high-amperage energy storage devices for stationary applications, advanced materials for use as electrodes in fused-salt electrolysis cells and batteries, electrochemical synthesis of compound semiconductors, and electrochemical synthesis of diamond coatings.

The related fundamental research is the physical chemistry and electrochemistry of molten salts (including molten oxides), cryogenic electro-lytes, and solid polymer electrolytes. As the owner of 13 US patents and more than 100 technical publications, Professor Sadoway provides expertise in battery materials and key experience and track record with United States Military research contracting.

Susan B. Sinnott, Professor of Materials Science & Engineering, Univ. of Florida



Susan Sinnott is Professor of Materials Science and Engineering at the University of Florida. She received a B.S. in Chemistry from the University of Texas at Austin and a Ph.D. in Physical Chemistry from Iowa State University. After working as a National Research Council Postdoctoral Fellow in the Surface Chemistry Branch of the Naval Research Laboratory, she became an Assistant Professor in the Department of Chemical and Materials Engineering at the University of Kentucky before moving to the University of Florida in 2000. Her research uses theoretical and computational tools to study the design, processing, and properties of materials. Problems of current interest include examining polymerization, thin film growth, and the targeted chemical modification of surfaces through particle-surface deposition, calculating the electronic structure of metal oxide defect structures, and predicting the properties of heterogeneous interfaces. Prof. Sinnott has published over 100 articles in peer-reviewed technical journals and has given over 100 invited presentations at technical conferences and institutions. She has also assisted in the organization of several symposia and conferences in her field. Recent awards include Fellow of the American Vacuum Society in 2005, NSF Creativity Award in 2005, and the University of Florida Materials Science and Engineering Faculty Excellence Award in 2002, 2003, 2004, 2005, 2006, and 2008.

Patrick Trapa, Principal Scientist, Pfizer, Inc.



Patrick Trapa received his S.B. and Ph.D. from MIT with research specializing in nanoscaled self-assembling polymer electrolytes. He synthesized and characterized the systems, modeled ion transport through the electrolytes, and validated his findings with electrochemical experiments. Upon graduation, Patrick cofounded a battery company and later served as a director of electrochemistry at Electrovaya, a publicly traded battery company located in Canada. In 2006, he joined Pfizer as a principal scientist in Research Formulations (RF), and is an active member of project teams spanning from very early discovery through Phase II clinical trials. In 2007, he led a team tasked to improve, integrate, and assess various ADME models. The team also investigated the supporting in vitro assays which provide necessary input parameters to the programs.

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G. Kumar Venayagamoorthy, Associate Professor of Electrical and Computer Engineering, Missouri University of Science and Technology



Dr. Ganesh Kumar Venayagamoorthy (S'91–M'97–SM'02) received the B.Eng. degree (Hons.) in electrical and electronics engineering from Abubakar Tafawa Balewa University, Bauchi, Nigeria, in 1994, and the M.Sc.Eng. and Ph.D. degrees in electrical engineering from the University of Natal, Durban, South Africa, in 1999 and 2002, respectively. He was a Senior Lecturer with the Durban Institute of Technology, Durban, prior to joining the Missouri University of Science and Technology (Missouri S&T), Rolla, USA in 2002. Currently, he is an Associate Professor of Electrical and Computer Engineering and Director of the Real-Time Power and Intelligent Systems Laboratory at Missouri S&T. He was a Visiting Researcher with ABB Corporate Research, Sweden, in 2007. His research interests are the development and applications of computational intelligence for real-world applications, including power systems stability and control, FACTS devices, power electronics, alternative sources of energy, sensor networks, collective robotic search, signal processing, and evolvable hardware. He has published 2 edited books, 5 book chapters, 60 refereed journals papers, and over 220 refereed international conference proceeding papers. He has attracted in excess US \$6.5 Million in competitive research funding from external funding agencies.

Mark Verbrugge, Director, Materials and Processes Laboratory, General Motors Research and Development Center



Mark Verbrugge started his GM career in 1986 with the GM Research Labs after receiving his doctorate in Chemical Engineering from the College of Chemistry at the University of California (Berkeley). Mark has published and patented in topic areas associated with electroanalytical methods, polymer electrolytes, advanced batteries and supercapacitors, fuel cells, high-temperature air-to-fuel-ratio sensors, surface coatings, compound semiconductors, and various manufacturing processes related to automotive applications of structural materials.

Mark's research efforts resulted in his receiving the Norman Hackerman Young Author Award (1990) and the Energy Technology Award (1993) from the Electrochemical Society as well as GM internal awards including the John M. Campbell Award (1992), the Charles L. McCuen Award (2003), and the Boss Kettering Award (2007). In 2006, Mark received the Lifetime Achievement Award from the United States Council for Automotive Research.

In 1996, Mark was awarded a Sloan Fellowship to the Massachusetts Institute of Technology, where he received an MBA. Mark returned from MIT in 1997 to join GM's Advanced Technology Vehicles (ATV) as Chief Engineer for Energy Management Systems. In 2002, Mark rejoined the GM Research Labs as Director of the Materials and Processes Lab, which maintains global research programs ranging from chemistry, physics, and materials science to the development of structural subsystems and energy storage devices. Mark is a Board Member of the United States Automotive Materials Partnership and the United States Advanced Battery Consortium, an adjunct professor for the Department of Physics, University of Windsor, Ontario, Canada, and he serves as the GM Technical Director for HRL Laboratories, LLC, jointly owned by GM and Boeing.

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Paul Werbos, Program Director, National Science Foundation

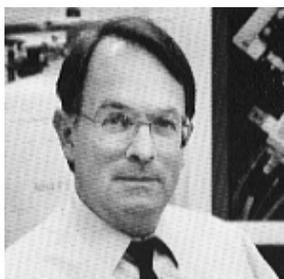


Dr. Paul Werbos has core responsibility for the Adaptive and Intelligent Systems (AIS) Area within the Power, Control and Adaptive Networks (PCAN) Program of ECCS, and for the new area of Quantum, Molecular and High-Performance Modeling and Simulation for Devices and Systems (QMHP). He is the ECCS representative for Collaborative Research in Computational NeuroScience and for the Engineering working group in Adaptive Systems Technology. He initiated and has led the EFRI-2008 topic in Cognitive Optimization and Prediction. He has special interest in efforts to exploit higher levels of true computational intelligence in these areas, and in efforts which can seriously increase the probability that we achieve global sustainability. In 1994, he initiated an SBIR topic on fuel cell and electric cars which he coordinated for several years. He was part of the group which proposed and led NSF's earlier initiative in Learning and Intelligent Systems, and assisted the follow-on in Information Technology Research. He has at times handled the ECCS areas in electric power and wireless communications when there were gaps in those areas.

Dr. Werbos is an elected member of the Governing Board of the International Neural Network Society (INNS), for which he was one of the original three two-year Presidents. He has also served as an elected member of the Administrative Committee (AdCom) of the IEEE Computational Intelligence Society (CIS), which he continues to represent on the IEEE-USA Energy Policy Committee. For IEEE-USA and as chair of the CIS Task Force on Alternative Energy, he has given a number of major talks to Congressional staff on energy policy, and helped to organize the IEEE-USA workshop on plug-in hybrid cars. He also serves on the AdCom of the IEEE Industrial Electronics Society. He is a Fellow of the IEEE, and has won its Neural Network Pioneer Award, for the discovery of the "backpropagation algorithm" and other basic neural network learning designs such as Adaptive Dynamic Programming. He also serves on the Planning Committee of the ACUNU Millennium Project (see www.stateofthefuture.org), whose annual report on the future tends to lead global lists of respected reports on the long-term future. In 2002, he and John Mankins of NASA initiated and ran the NASA-NSF-EPRI initiative on enabling technologies for space solar power (search on "JIETSSP" at www.nsf.gov). In 2003, he participated on the interagency working group for the Climate Change Technology Program. He has a paper in press at Futures on a rational strategy for the economic development of space, and has been nominated for the Governing Board of the National Space Society.

He holds four degrees from Harvard and the London School of Economics in: (1) economics; (2) international political systems, emphasizing European economic institutions; (3) applied mathematics, with a major in quantum physics and a minor in decision and control; (4) applied mathematics for an interdisciplinary PhD. Prior to that, during high school, he obtained an FCC First Class Commercial Radiotelephone license, and took undergraduate and graduate mathematics courses at Princeton and the University of Pennsylvania.

M. Stanley Whittingham, Professor of Chemistry and Materials Science, SUNY at Binghamton



M. Stanley Whittingham read Chemistry at the University of Oxford, where he took his BA (1964), MA (1967), and DPhil (1968). After completing his graduate studies, Dr. Whittingham was a postdoctoral fellow at Stanford University until 1972. He then worked for Exxon Research & Engineering Company from 1972 until 1984. He then spent four years working for Schlumberger prior to becoming a professor at Binghamton University. For five years, he served as the University's vice provost for research and outreach. He also served as Vice-Chair of the Research Foundation of the State University of New York for six years.

Dr. Whittingham is a key figure in the history of the development of rechargeable batteries discovering the concept of intercalation electrodes. He is the holder of 16 US patents and has over 220 journal publications in his name. Exxon commercialized the first rechargeable lithium-ion battery, which was based on a titanium disulfide cathode and a lithium-aluminum anode. He developed the hydrothermal synthesis technique for making cathode materials, which is now being used commercially for the manufacture of lithium iron phosphate by Phostech/Sud-Chimie in Montreal, Canada.

He received the Young Author Award from the Electrochemical Society in 1971, the Battery Research Award in 2004, and was elected a Fellow in 2006 for his contributions to lithium battery science and technology.