



# 25th Anniversary Celebration

of

# Cornell NanoScale Facility

Wednesday, October 6<sup>th</sup>, 2004  
Cornell University



# 25th Anniversary Celebration of CNF

Wednesday, October 6<sup>th</sup>, 2004

Barnes Hall Auditorium, Cornell University Campus

**8:00 am Registration**

**8:30 Welcome:**

**Sandip Tiwari**, Professor, Electrical and Computer Engineering, Cornell University;  
Lester B. Knight Director, Cornell NanoScale Facility

## MORNING SESSION: SCIENCE AND TECHNOLOGY: THEIR ROLE IN SOCIETY

**Moderator: Robert C. Richardson**, Vice Provost for Research, Cornell University

**8:40 Keynote Address:**

**Roald Hoffmann**, Frank H. T. Rhodes Professor of Humane Letters,  
Chemistry and Chemical Biology, Cornell University

**9:25 Featured Remarks**

**Thomas Everhart**, President Emeritus, California Institute of Technology

**Alec Broers**, Former Vice-Chancellor of the University of Cambridge,  
President of the Royal Academy of Engineering

**John Armstrong**, Retired Vice President for Science & Technology, and Director of Research, IBM

**Charles E. Sporck** '51 EE, Former CEO, National Semiconductor Corporation

**Irwin Jacobs** '54 EE, Founder and CEO, QUALCOMM

**10:15 Panel Discussion**

**12-1:20pm Lunch** (*Willard Straight Hall Memorial Room*)

## AFTERNOON SESSION: ROLE AND ISSUES OF UNIVERSITY RESEARCH

**Moderator: W. Kent Fuchs**, Joseph Silbert Dean of the College of Engineering, Cornell University

**1:30 Keynote Address:**

**David Auston**, President, Kavli Foundation

**2:15 Featured Remarks**

**Venkatesh Narayananamurti**, Dean, Division of Engineering and Applied Sciences, and  
Dean, Physical Sciences; Harvard University

**Myriam Sarachik**, Past President, American Physical Society; Distinguished Professor of Physics,  
City College of the City University of New York

**Jay Harris**, Professor, Electrical and Computer Engineering, San Diego State University

**Lawrence Goldberg**, Senior Engineering Adviser, The National Science Foundation

**Edward Wolf**, Professor Emeritus, School of Electrical and Computer Engineering,  
Cornell University; Director, National Research and Resource Facility  
for Submicron Structures (now CNF)

**Robert Buhrman**, John Edson Sweet Professor of Engineering, Applied and Engineering Physics;  
Director, Center for Nanoscale Systems, Cornell University

**3:15 Panel Discussion**

**5:30 Adjourn**

**National Research and Resource Facility for Submicron Structures, 1977-1987**

**National Nanofabrication Facility, 1987-1993**

**Cornell Nanofabrication Facility, 1993-2002**

**Cornell Nanoscale Science & Technology Facility, 2003-**

## A Brief History

**Edward D. Wolf**

**Director of NRRFSS and NNF (1978-1988)**

**Professor Emeritus (1991)**

**School of Electrical and Computer Engineering**

**Cornell University, Ithaca, NY 14853**

The Cornell Nanoscale Science & Technology Facility (CNF) had its beginnings within the National Science Foundation (NSF) during the mid-1970s. During 1976 NSF held three workshops across the country to assess the need and requirements for a university-based national research and resource facility for submicron structures (NRRFSS). As a result NSF issued a request for proposals. The winning proposal from Cornell University was promoted and coordinated by Prof. Joseph M. Ballantyne, School of Electrical and Computer Engineering. There were four other site visit finalists which included several leading universities.

To facilitate the creation of the NRRFSS in 1977, Cornell appointed Prof. Ballantyne as Acting Director, assembled a Program Committee to advise him on equipment and program issues, and rallied faculty to respond to the 5-yr \$5-million grant which provided for 2 million dollars in equipment purchases and 750 thousand dollars per year for four years of program support. The initial Program Committee was chaired by Prof. Paul McIsaac and its members were selected from both academia and industry: Profs. W.S.C. Chang (Washington University) and T.H. Henderson (Univ. of Cincinnati), Drs. A.N. Broers (IBM Yorktown), R.F.W. Pease (Bell Labs), and E.D. Wolf (Hughes Research Labs). Drs. E.R. Chenette and later, J. Harris, were the NSF representatives and Profs. J.M. Ballantyne, B.W. Batterman, G.C. Dalman, L.F. Eastman, C.A. Lee, A.L. Ruoff, and B.M. Siegel were the Cornell representatives on the committee. A Policy Board was also created to give long range guidance to the facility. Its members at the end of the first year were Prof. T.E. Everhart (UC-Berkeley and later Dean of Engineering at Cornell) and Drs. G. Moore (Intel), K. Patel (Bell Labs), and H. Caswell (IBM).

Each major equipment purchase was the focus of one or more faculty members who determined the capabilities and best vendor. The mode of offering research and resource capabilities was to be through graduate students and a small support staff. The facility was to be located in renovated space within Phillips Hall, home of the School of Electrical and Computer Engineering, at a cost of about 600 thousand dollars.

I became a candidate for the directorship and joined Cornell in July 1978. During the first several years my focus as director was on securing an adequate full-time technical staff to operate and repair more effectively the growing capital equipment investment (current replacement price is about 30 million dollars) and to design and build a clean room facility that would be durable and adequate to the tasks before us. So we changed from individual faculty to staff responsibility for equipment operation and repair, and from a renovated 4th-floor space in Phillips Hall to a new site on ground level for the new lab. Necessarily, the price tag for both NSF and Cornell went up dramatically. We built a 4.2 million dollar facility with a 7,500 sq. ft. clean room which we moved into during the fall of 1981. It was designed for about 60 users. The new lab provided local Class 10 processing in a Class 500 ambient with very low electromagnetic fields and mechanical vibration. Lester B. Knight (Cornell '29) endowed a majority of the construction costs. By our fifth year we had garnered an annual core budget from NSF of about a 1.5 million dollar. We also had excellent financial support and encouragement from Cornell administration, namely Deans of

Engineering Edmund Cranch and Thomas E. Everhart, Provost W. Keith Kennedy, and President Frank H.T. Rhodes. This successful period of growth and transition was possible only through the unfailing interest and support of a core group of Cornell faculty from ECE, applied and engineering physics, and materials science and engineering. In addition, Prof. Ballantyne created the industrial affiliates program called the Program on Submicron Structures or PROSUS during the second year of the grant which would grow to a peak membership several years later of 44 member companies and provide nearly 400 thousand dollars of annual support to the operating budget, which averaged about 4 million dollars during the mid to late 1980s.

Over the next fifteen years (1982-1997), the operation of the facility remained at a nearly steady state with about twenty full-time staff members servicing as many projects as was humanly possible (202 in 1997). Directors come and go, but the long-term success of the facility is primarily the result of talented and persevering staff members who often work well into the night during the short visits by researchers from other institutions. CNF staff members must astutely bridge the gap between wishful thinking by users and what is possible. They are, or become, the resident expert in their particular area of nanofabrication. The user generally leaves satisfied and impressed, and the facility advances in its capability with a greater appreciation of the wide range of user needs. There is a quotation that, I believe, is embodied in the work ethic of the CNF staff. The quotation is found in the south entrance to the Statler Hotel complex on campus, and reads, “Life is service – the one who progresses is the one who gives his fellow man a little more – a little better service” and is attributed to E.M. Statler.

During this period the facility evolved at Cornell from a College of Engineering facility to a University facility (1987), and in name from the National Research and Resource Facility for Submicron Structures to the National Nanofabrication Facility (1987). Prof. Harold Craighead, School of Applied and Engineering Physics (recruited from Bellcore) became the second director of the facility in 1988. Harold became the first Lester B. Knight director, as a consequence of the Knight family endowment of the directorship during his tenure. Prof. Noel C. MacDonald, School of Electrical and Computer Engineering, served as the third director of the facility from 1995 to 1997 when he left to assume a position at DARPA. Prof. Joseph M. Ballantyne served as the interim Lester B. Knight Director of CNF from 1997 to 1998, when Dr. Sandip Tiwari accepted the directorship, recruited from IBM.

While many faculty, associate directors, and staff deserve mentioning by name, I will only mention three. Dr. Gregory Galvin served as associate director from 1984 to 1989 and was an outstanding administrator prior to, during, and after my sabbatical leave at Cambridge University in 1986-87. He led and contributed significantly to all aspects of the facility’s growth and operation. More recently, Dr. Alton Clark, a physicist and former VP at Carborundum Corporation, was a key administrator in his position as associate director and helped the facility transition through three directorships. The facility benefited from his superbly organized and efficient leadership. Dr. Lynn Rathbun has become the ‘senior’ facility staff member and has contributed greatly to the formation of the NNUN (see later), to other critical proposals, and to the documentation of CNF accomplishments over the years.

In 1993, NSF enlarged the funding and number of nanofabrication facilities. Cornell University won the competition for the National Nanofabrication Users Network (NNUN) with the Cornell Nanofabrication Facility a key facility among five laboratories; Cornell, Stanford University, University of California at Santa Barbara, The Pennsylvania State University, and Howard University. In 1998, the NNUN was notified of another five years of funding. It is only fitting that Prof. Ballantyne, who was key in winning the original 1977 competition for the facility, was at the helm as director when CNF was awarded this funding. During the 10 years as part of NNUN, the CNF user base grew dramatically. NNUN served as a model for national funding of facility networks, and set the stage for an even larger nanotechnology network.

In 2003, Cornell University was honored to be awarded the National Nanotechnology Infrastructure Network (NNIN) competition. This expanded network includes 12 sites and 1 affiliate; Cornell, Georgia Institute of Technology, Harvard, Howard, Pennsylvania State, Stanford, University of California at Santa Barbara, University of Michigan, University of Minnesota, University of New Mexico, University of Texas at Austin, University of Washington, and its affiliate at North Carolina State. Today, CNF serves nearly 750 regular users in a year across a broad range of subject areas. More than 70 faculty members from Cornell and a similar number from other academic institutions, nearly 550 graduate students, 300 of whom are from Cornell, and 200 industrial users, the impact of CNF can be felt across the country’s research landscape.

Integral to a successful research initiative is the funding and oversight of that national trust of taxpayers' money. The National Science Foundation has been there from the very beginning and remains an effective guiding influence to this day for CNF, NNIN and nanotechnology in the broadest of perspective. At the time of the establishment of NRRFSS, NSF was itself in transition. The Directorate for Engineering was just being established with Dr. Sanderson serving as the first director. One of the great concerns then was how much NRRFSS was draining funding from individual grants at NSF. Fortunately, the Engineering Directorate moved on to create a large number of differently named "centers" to the great benefit of engineering and the nation. Key to this important stewardship and to the success of the facility are the many past NRRFSS/NNF/CNF program directors. I would like to name one in particular, Prof. Dr. Ronald Gutmann, who served admirably and astutely, from my perspective, as a NSF program director. He served, on leave from Rensselaer Polytechnic Institute, during the early key period in the history of CNF as it began its transition from NRRFSS to NNF. Dr. Lawrence Goldberg, NSF senior engineering advisor, provides this invaluable guidance and oversight to CNF and NNIN today.

I mentioned earlier that directors come and go, however, that statement is a little too glib for all past directors and particularly for the current director. No brief history of CNF is complete without special mention of Professor Director Sandip Tiwari. Cornell and the national nanotechnology community owe him deep appreciation and gratitude for his leadership and stewardship of CNF, NNUN, and now NNIN. His management and knowledge of nanoscience and technology guided the successful transition from NNUN to NNIN, a continuation of the national "franchising" of CNF. Under his tenure the 23-year old NRRFSS laboratory was literally buried and the new CNF was moved to much larger and much improved facilities in Duffield Hall. Balancing expectations with the hard realities of moving a functioning national user laboratory was a feat accomplished quite successfully by Dr. Tiwari and his CNF staff. In his spare time he teaches in ECE, is the Editor-in-Chief of IEEE Transactions on Nanotechnology, and he and his students are carrying out research that is at the cutting edge of nanoscale science and engineering. He came well prepared and when he steps down as the Knight Director of CNF he will leave CNF better prepared for enabling nanotechnology studies than ever before. The installation and rapid attainment of full operational status of the new \$6 million JEOL JBX 9300 FS e-beam lithography system in late 2003 and early 2004 was a major milestone for CNF. This state-of-the-art system provides minimal feature-sizes approaching  $\sim 10$  nm. This is a limit set by current polymeric resist resolution not electron beam spot-size.

In closing this updated brief history, it is noteworthy that CNF continues to provide uniquely enabling nanotechnology for a wide spectrum of science and engineering research at a university, founded by Ezra Cornell, under the motto, "I would found an institution where any person can find instruction in any study."





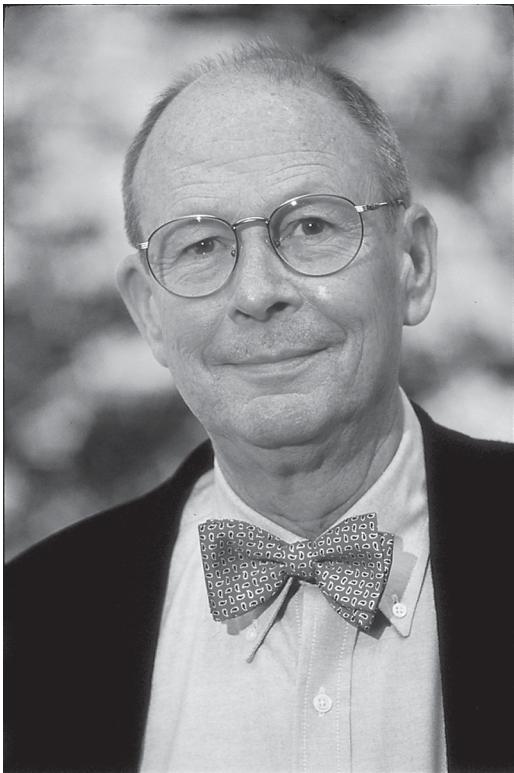
## Sandip Tiwari

**Professor, Electrical and Computer Engineering,  
Cornell University; Lester B. Knight Director,  
Cornell NanoScale Facility**

Sandip Tiwari is Professor of Electrical and Computer Engineering at Cornell University, Lester B. Knight Director of Cornell NanoScale Facility and Director of National Nanotechnology Infrastructure Network. His current research interests are in small devices and their circuits, in ideas and technologies that allow functional integration, and in interesting offshoots of small structures in other areas.

Among his contributions and inventions that have found large industrial application and research interest are: nano-crystal and quantum-dot low power embedded memories, power-adaptive technologies, vertical transistors in multi-Gbit DRAM memories, and the technology of heterostructure bipolar transistor used in wireless applications. His fundamental contributions include understanding of heterostructure bipolar transistors, particularly the alloy barrier effect and surface recombination, gain compression with multi-dimensional confinement in semiconductor lasers, and the physics of operation of memories employing confinement and single-electron effects for storage.

Sandip Tiwari has been a Research Staff Member and Manager for Exploratory Devices and Device Modeling at IBM, has held visiting and adjunct faculty appointments at the University of Michigan and Columbia University, is a Fellow of IEEE and APS, and received the Young Scientist Award of 1991 from Institute of Physics and the Distinguished Alumnus Award from IIT Kanpur in 2003. He is author of the text "*Compound Semiconductor Device Physics*" and is the founding Editor-in-Chief of IEEE Transactions on Nanotechnology.



## **Robert C. Richardson**

**Vice Provost for Research, Cornell University**

Bob Richardson was born on June 26, 1937 in Washington, DC. He grew up in the Washington suburb of Arlington, Va. He attended the Arlington County public schools and graduated from Washington-Lee High School in 1954. He was very active in the Boy Scouts. He became an Eagle Scout and especially enjoyed the outdoor activities of scouting - hiking, camping, and even bird watching.

He attended Virginia Polytechnic Institute between 1954 and 1960 where he obtained both B.S. and M.S. degrees in physics. After a brief time in the United States Army he returned to graduate school in physics at Duke University. His thesis work involved NMR studies of solid He<sup>3</sup>. He obtained his Ph. D. degree from Duke in 1966. His thesis advisor was Professor Horst Meyer.

In the Fall of 1966 Bob began work at Cornell University in the laboratory of David Lee. Their research goal was to observe the nuclear magnetic phase transition in solid He<sup>3</sup> that could be predicted from Richardson's thesis work with Horst Meyer at Duke. In collaboration with Douglas Osheroff, a student who joined the group in 1967, they worked on cooling techniques and NMR instrumentation for studying low temperature helium liquids and solids. In the Fall of 1971, they made the accidental discovery that liquid He<sup>3</sup> undergoes a pairing transition similar to that of superconductors. The three were awarded the Nobel Prize for that work in 1996. Bob has been on the Cornell faculty since 1967. He is currently the F. R. Newman Professor of Physics and the Vice Provost for Research. In the more than 35 years at Cornell he has led an active research program in studies of matter at very low temperatures. In that time 20 students have earned Ph. D. degrees while working with him. He has published more than 95 scientific articles in major research journals. He has been active in teaching introductory physics throughout his time at Cornell. He prepared a series of video taped lectures for Physics 101 and 102, the course for biology students, in 1985.

Bob's wife, Betty Richardson, is a Senior lecturer in physics at Cornell. For the past seven years the Richardsons have worked with Alan Giambattista, also of Cornell, on the production of an introductory college physics text book. The book, College Physics, is an algebra based text which was published by McGraw-Hill in Feb. 2003.



## Roald Hoffmann

**Frank H. T. Rhodes Professor of Humane Letters,  
Chemistry and Chemical Biology, Cornell University**

Roald Hoffmann was born in 1937 in Zloczow, Poland. Having survived the war, he came to the U. S. in 1949, and studied chemistry at Columbia and Harvard Universities (Ph.D. 1962). Since 1965 he is at Cornell University, now as the Frank H. T. Rhodes Professor of Humane Letters. He has received many of the honors of his profession, including the 1981 Nobel Prize in Chemistry (shared with Kenichi Fukui).

“Applied theoretical chemistry” is the way Roald Hoffmann likes to characterize the particular blend of computations stimulated by experiment and the construction of generalized models, of frameworks for understanding, that is his contribution to chemistry. The pedagogical perspective is very strong in his work

Notable at the same time is his reaching out to the general public; he participated, for example, in the production of a television course in introductory chemistry titled “The World of Chemistry,” shown widely since 1990. And, as a writer, Hoffmann has carved out a land between science, poetry, and philosophy, through many essays and three books, *Chemistry Imagined* with artist Vivian Torrence, *The Same and Not the Same* and *Old Wine, New Flasks: Reflections on Science and Jewish Tradition*, with Shira Leibowitz Schmidt.

Hoffmann is also an accomplished poet and playwright. He began writing poetry in the mid-1970s, eventually publishing the first of a number of collections, *The Metamict State*, in 1987, followed three years later by *Gaps and Verges*, then *Memory Effects* (1999), *Soliton* (2002), and most recently, in Spanish, *Catalista*. He has also co-written a play with fellow chemist Carl Djerassi, entitled *Oxygen*, which has been performed worldwide, translated into ten languages.



## Thomas Everhart

**President Emeritus, California Institute of Technology**

Thomas E. Everhart is President Emeritus of the California Institute of Technology in Pasadena, California and also Professor of Electrical Engineering and Applied Physics, Emeritus. He received an A.B. degree in physics “magna cum laude qui adseculus est summos honores” in 1953 from Harvard University. He received his M.Sc. degree from the University of California at Los Angeles in 1955, and earned a Ph.D. in engineering from Cambridge University, Cambridge, England, in 1958, where he was a Marshall Scholar.

Everhart spent more than twenty years at the University of California at Berkeley as a faculty member in Electrical Engineering and Computer Sciences, chairing the department for five years. He subsequently was the Joseph Silbert Dean of Engineering at Cornell University from 1979-84, the Chancellor of the University of Illinois at Urbana-Champaign from 1984-87, before serving as President of Caltech from 1987-97. He served as Pro-Vice-Chancellor of Cambridge University for five months in 1998. He currently holds a guest appointment at the University of California at Santa Barbara, is the Senior Scientific Adviser of the W. M. Keck Foundation, and a member of the Board of the Kavli Foundation.

Everhart has served on the National Academy of Engineering Council. He has chaired the Secretary of Energy Advisory Board, General Motors Science Advisory Committee, and the Lawrence Berkeley Laboratory Scientific and Educational Advisory Committee. He is a member of the Board of Directors of Saint-Gobain and Raytheon Company. He has been a member of the Agilent, Hewlett-Packard, General Motors, Hughes Electronics, and Electric Power Research Institute Boards of Directors. He is a member of the California Institute of Technology Board of Trustees and the Harvard Board of Overseers, which he chairs during 2004-2005. He is a Foreign Member of the Royal Academy of Engineering (Great Britain).



## Sir Alec Broers

**Former Vice-Chancellor, University of Cambridge; President, Royal Academy of Engineering**

Sir Alec Broers began his career at Cambridge in King's College chapel where he sang his way into a choral scholarship at Gonville and Caius in 1960. He had already taken a first degree in Physics at Melbourne University in Australia, followed by a further year of studying electronics. He decided to come to Cambridge as it was then the Mecca for his passion, electronics, and had the added attraction of some fine choirs. Despite already having two first degrees from Melbourne, he was advised to enroll as an undergraduate before undertaking a PhD, which turned out to be "one of the best moves I ever made". He decided to take the Electrical Engineering Tripos and recalls spending most of his time singing (up to 20 hours a week) playing squash and sailing. Having graduated with his BA in 1962, he then started the serious business of his PhD, working with Professor Oatley to begin with on scanning electron microscopes, and later with Dr William C. Nixon.

However his work was not on using the microscopes for visual observations, but on using them as a tool to scribe things. This was the pioneering work in nanotechnology that has led to the production of the now familiar miniature electronic circuits which are part of all of our lives today. "I had a marvellous time doing research" he recalls "I had essentially turned my hobby into my career."

He then moved to the IBM research laboratories in New York: "I went for two years and stayed for twenty." In 1977 he was made an IBM fellow. This gave him the freedom to follow whatever road of enquiry he wished, with no commercial constraint. But in 1984 Alec Broers was tempted back to Cambridge to the Chair of Electrical Engineering. It was this move that really brought the Department to the forefront in the world of nanotechnology research, and as Head of Electrical Engineering, Alec was keen to maintain the breadth of research in Electrical Sciences from power engineering to nanotechnology. One mark of Alec Broer's vision at this time was that the University decided to set up a School of Technology that was to include Chemical Engineering, the Computer Laboratory and the Judge Institute of Management Studies. This fantastically successful appointment was not to last for long however as Professor Broers was called to higher things in 1996 when he was appointed Vice Chancellor to the University, the first time that such a post has been held by an engineer. Those early opponents of the study of engineering at Cambridge in the late nineteenth century must be turning in their graves.



## **John Armstrong**

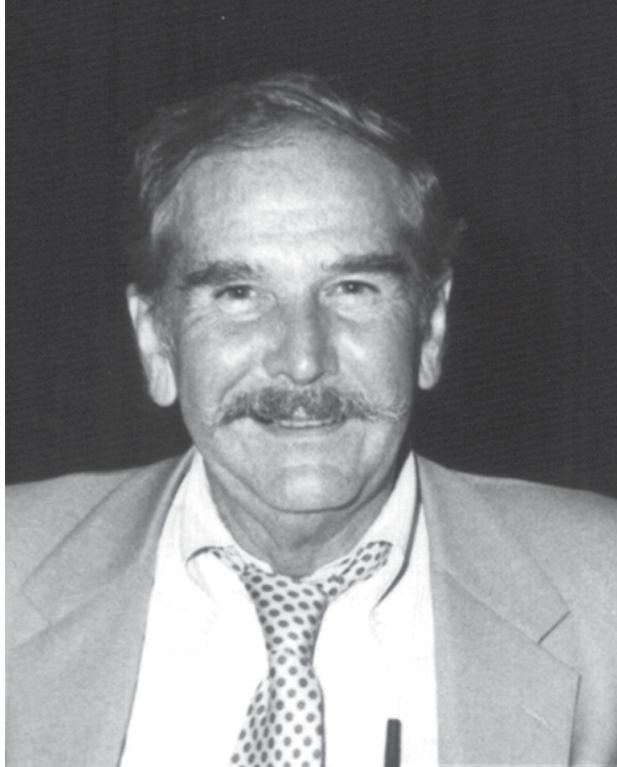
**Retired Vice President for Science and Technology,  
and Director of Research, IBM**

John Armstrong, retired IBM VP and Director of Research, received a Ph.D. from Harvard in 1961 and remained there as a Research Fellow working with Prof. N. Bloembergen in nonlinear optics until 1963, when he joined IBM Research working in nonlinear optics, picosecond pulse measurements, and multi-photon ionization spectroscopy.

During the 70's he was manager of the physical sciences programs at the T. J. Watson Research Center, and during 1981-83 he was manager of materials and technology development at the IBM East Fishkill development laboratory, with responsibility for advanced development of high speed bipolar integrated circuits and associated interconnection technology. In 1986 he was named IBM Director of Research, and in 1987 was elected an IBM Vice President. In 1989 he was elected a member of the Corporate Management Board and named VP, Science and Technology. He retired from IBM in 1993.

Armstrong is the author or co-author of some 60 papers on nuclear resonance, nonlinear optics, the photon statistics of lasers, picosecond pulse measurements, the multiphoton spectroscopy of atoms, the management of research in industry, and issues of science and technology policy. He received the 1989 George E. Pake Prize of the American Physical Society.

He is a member of the National Academy of Engineering, is a foreign member of the Royal Swedish Academy of Engineering Sciences, and was a member of the Harvard University Board of Overseers (1990-96). He was Chair of the Governing Board of the American Institute of Physics from 1999-2003, and a Member of the National Science Board from 1996-2002.



## **Charles E. Sporck '51 ECE**

**Former CEO, National Semiconductor Corporation**

Charles Sporck was born in 1927, in Saranac Lake, NY. He joined the U.S. army in June of 1945 and served until February 1947. Charles attended Cornell University, receiving his BME in 1951. He then went to work at General Electric, in the capacitor department, from 1951 through 1959. In 1959, Charles was hired by Fairchild Semiconductor as a production manager, and he moved through the Fairchild ranks, becoming operations manager in 1961, and general manager in 1963. In 1967, Charles became CEO of the National Semiconductor Corporation.

Now retired, Charles was a founder of the Semiconductor Industry Association, and a founder of the Semiconductor Research Corporation. He was also the first chairperson of Sematech.



## **Irwin Jacobs '54 ECE**

**Founder and CEO, QUALCOMM**

Dr. Irwin Mark Jacobs is co-founder, chairman and CEO of San Diego-based QUALCOMM Incorporated, a world leader in developing and delivering digital wireless communications products and services. Dr. Jacobs pioneered QUALCOMM's Code Division Multiple Access (CDMA) digital wireless technology, and has led the commercialization of CDMA technology and its success as the world's fastest-growing, most advanced voice and data wireless communications technology. Now used by tens of millions of consumers worldwide, CDMA is the technology of choice for third-generation wireless communications services.

Dr. Jacobs previously served as co-founder, president, chairman and CEO of LINKABIT Corporation, directing its growth from a few part-time employees in 1969 to over 1,400 employees in 1985. Upon LINKABIT's merger with M/A-COM in 1980, Dr. Jacobs served on the company's board of directors until he resigned from M/A-COM in 1985. Over 35 San Diego communications companies trace their roots back to LINKABIT.

From 1959 to 1966, Dr. Jacobs was an assistant/associate professor of electrical engineering at Massachusetts Institute of Technology (MIT). From 1966 to 1972 he served as a professor of computer science and engineering at the University of California, San Diego (UCSD).

Dr. Jacobs received a bachelor's degree in electrical engineering in 1956 from Cornell University and master of science and doctor of science degrees in electrical engineering from MIT. He is a Fellow of the IEEE and a member of Sigma XI, Phi Kappa Phi, Eta Kappa Nu, and Tau Beta Pi. Dr. Jacobs also serves on the Council on Competitiveness, the National Academy of Engineering Committee on Public Awareness of Engineering, the board of directors of Building Engineering & Science Talent, the visiting committee of the MIT Laboratory for Information and Decision Systems, California Council on Science and Technology, and is past chairman of the University of California President's Engineering Advisory Council.



## **W. Kent Fuchs**

**Joseph Silbert Dean of the College of Engineering, Cornell University**

W. Kent Fuchs was appointed Joseph Silbert Dean of the College of Engineering at Cornell University on July 1, 2002. A specialist in dependable computing, testing and failure diagnosis, Fuchs (pronounced fox) will serve a five-year, renewable term. Commenting on his appointment, he said, "It is a great honor to lead one of the world's finest colleges of engineering. I look forward to serving the Cornell faculty, students and alumni with dedication, energy and enthusiasm."

Fuchs obtained his bachelor of science engineering degree at Duke University in 1977, his master of science degree at the University of Illinois in 1982, his master of divinity degree at Trinity Evangelical Divinity School in 1984, and his doctorate in electrical engineering at the University of Illinois in 1985.

Fuchs came to Cornell from Purdue University where he was head of the School of Electrical and Computer Engineering and the Michael J. and Catherine R. Birck Distinguished Professor. He led two research groups at Purdue: computer-aided design tools for testing and failure analysis in integrated circuits; and dependable mobile computing, active networks, and high-performance computing. Prior to being named head of Purdue's electrical and computer engineering school in 1996, Fuchs was a professor at the University of Illinois in the Coordinated Science Laboratory and the Department of Electrical and Computer Engineering. He joined the University of Illinois in 1985 as an assistant professor. He was named a full professor in 1993.

His research awards include, from the University of Illinois, the Senior Xerox Faculty Award for Excellence in Research, selection as a University Scholar, appointment as fellow in the Center for Advanced Studies, and the Xerox Faculty Award for Excellence in Research. He also received the Best Paper Award from the Institute of Electrical and Electronics Engineers (IEEE) and the Association of Computer Machinery (ACM) Design Automation Conference, and the Best Paper Award from the IEEE VLSI (very large scale integration) Test Symposium. He is a fellow of both the IEEE and the ACM. Among his many recent professional society activities, he was a member of the board of governors of the National Electrical Engineering Department Heads Association, 2000-2002, member of the IEEE Fellow selection committee, 1998-2002, and chair of the IEEE Technical Committee on Fault-Tolerant Computing in 2000.



## **David Auston**

### **President, Kavli Foundation**

David Auston is President of the Kavli Foundation, a new philanthropic organization based in Santa Barbara, California, that is dedicated to supporting basic scientific research and fostering increased public understanding and support for scientists and their work. With emphasis on the fields of astrophysics, nanoscience and neuroscience, the Foundation is implementing an international program of research institutes, professorships, prizes, and conferences to advance these goals.

Dr. Auston's professional career encompasses experience in both industry and higher education. He has been a member of the technical staff and department head at AT&T's Bell Laboratories (now Lucent Technologies); professor of Electrical Engineering and Applied Physics and Dean of the School of Engineering and Applied Science at Columbia University; Provost of Rice University; and President of Case Western Reserve University.

He has contributed to research in the fields of lasers, nonlinear optics, and solid-state materials. He is a member of the National Academy of Sciences, the National Academy of Engineering, and a Fellow of the American Academy of Arts and Sciences, the Institute of Electrical and Electronic Engineers, the Optical Society of America, and the American Physical Society.

A native of Toronto, Canada, David Auston earned bachelor's and master's degrees in engineering physics and electrical engineering from the University of Toronto and a Ph.D. in electrical engineering from the University of California, Berkeley.



## Venkatesh Narayananamurti

**Dean, Division of Engineering and Applied Sciences, Harvard University**

Venkatesh (“Venky”) Narayananamurti is Dean of Engineering and Applied Sciences and the John A. and Elizabeth S. Armstrong Professor of Engineering and Applied Sciences at Harvard University. He is also the Dean of Physical Sciences and a Professor in the Harvard Physics Department. From January 1992 to September 1998 he served as the Richard A. Auhll Professor and Dean of Engineering, as well as Professor of Electrical & Computer Engineering, at the University of California at Santa Barbara. He was Vice President of Research and Exploratory Technology at Sandia National Laboratories, Albuquerque, NM, from May 1987 to January 1992. He joined Bell Laboratories in 1968 and became Director of Solid State Electronics Research in 1981. He has published widely in the areas of low temperature physics, superconductivity, semiconductor electronics and photonics. He is credited with developing the field of phonon optics — the manipulation of monoenergetic acoustic beams at terahertz frequencies. He is currently very active in the field of semiconductor nanostructures.

Narayananamurti is a member of the National Academy of Engineering and the Royal Swedish Academy of Engineering Sciences. He is also a Fellow of the American Physical Society, the American Association for the Advancement of Science, the IEEE, and the Indian Academy of Sciences. Over the years he has served on numerous advisory boards of the federal government, research universities and industry. Currently he is a member of the Advisory Board for the University of California’s Miller Institute for Basic Science, a member of the Board of Brookhaven National Laboratory, and a member of the Dean’s Leadership Councils of Brown and Cornell Universities. In addition to his duties as Dean and Professor, Narayananamurti lectures widely on solid state, computer, and communication technologies, and on the management of science, technology and public policy.



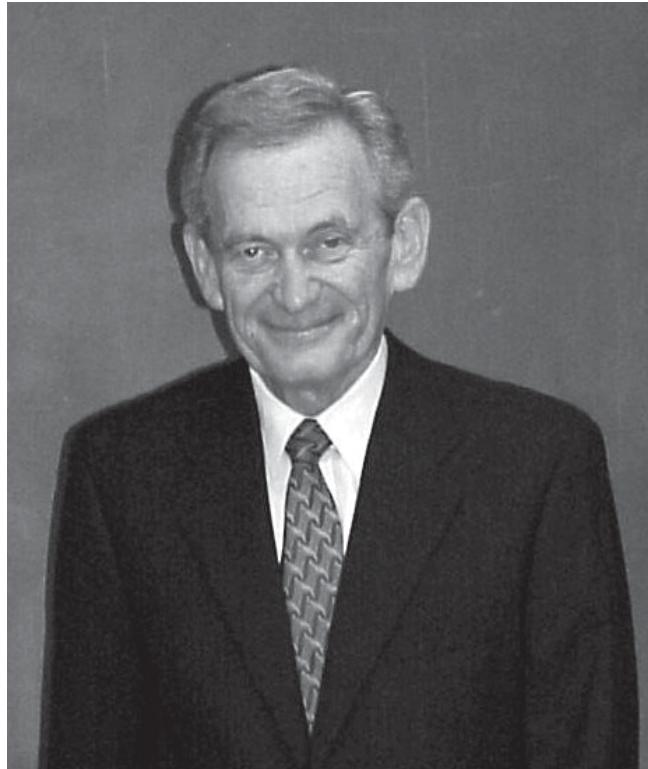
## **Myriam Sarachik**

**Past President, American Physical Society;  
Distinguished Professor of Physics,  
City College of the City University of New York**

Myriam Sarachik received a B.A. cum laude in Physics from Barnard College in 1954, and an M. S. (1957) and Ph.D. in Physics (1960) from Columbia University. Following two years as a postdoctoral Member of the Technical Staff at Bell Telephone Laboratories in Murray Hill, NJ, she joined the faculty of City College of New York, CUNY, in 1964, where she now holds the position of Distinguished Professor of Physics.

Sarachik's experimental work has contributed to the understanding of solids at low temperatures. Her thesis provided an early experimental determination of the energy gap predicted by the then-recent BCS theory of superconductivity. While at Bell Labs, she performed the definitive experiment that provided the underpinning for Jun Kondo's solution of the thirty-year old puzzle of the "resistance minimum". She has studied the critical behavior and scaling at and near the metal-insulator transition in doped semiconductors, and the hopping conduction on the insulating side of the transition. With her student Jonathan Friedman, she discovered quantum mechanical tunneling of the magnetization in a molecular nanomagnet.

Sarachik was elected to the National Academy of Sciences in 1994, received the NY City Mayor's Award for Excellence in Science and Technology in 1995, and the Sloan Public Service Award in 2004. She is a National Board Member of the Committee of Concerned Scientists, a fellow of the American Academy of Arts and Sciences, and a fellow of the American Association for the Advancement of Science, of the New York Academy of Sciences, and of the American Physical Society. She served as President of the American Physical Society in 2003.



## **Jay Harris**

**Professor, Department of Electrical and  
Computer Engineering, San Diego State University**

Dr. Harris' professional career began when he joined the Hughes Aircraft Company in 1958. His work with the company concerned research in antennas and wave propagation and included special studies for such programs as Surveyor, the first lunar soft-landing vehicle. His technical education includes degrees in Electrical Engineering from the former Polytechnic Institute of Brooklyn, where he was a New York State Scholar, and from Cal Tech and UCLA, where he was a Howard Hughes Fellow. He was also a Fulbright Fellow at the University of Paris at Orsay.

Dr. Harris' academic career began at the University of Washington where he served as Professor of Electrical Engineering from 1966 to 1974. His research at the university dealt with thin film and fiber optics and with biomedical measurements. He served as a Traveling Lecturer for the Optical Society of America and as a Visiting Lecturer at the Weizmann Institute in Israel. He was named a Fellow of the IEEE for his contributions to Integrated Optics.

Dr. Harris served as Director of the Devices and Waves Program, as well as other programs, at the National Science Foundation from 1974 to 1980. At the Foundation, he initiated efforts that led to federal support for nanostructure and nanofabrication research. He was the recipient of an NSF Special Achievement Award.

Dr. Harris served as Dean of the College of Engineering at San Diego State University from 1980-82. Federally funded research activities in the college rose to national leadership levels for masters level institutions during this period. Dr. Harris presently serves as Professor of Electrical and Computer Engineering at SDSU with interests in VLSI, error correction codes, and video signal processing. He has received several teaching awards while at SDSU, including the TRW Award for Excellence in Teaching.



## **Lawrence Goldberg**

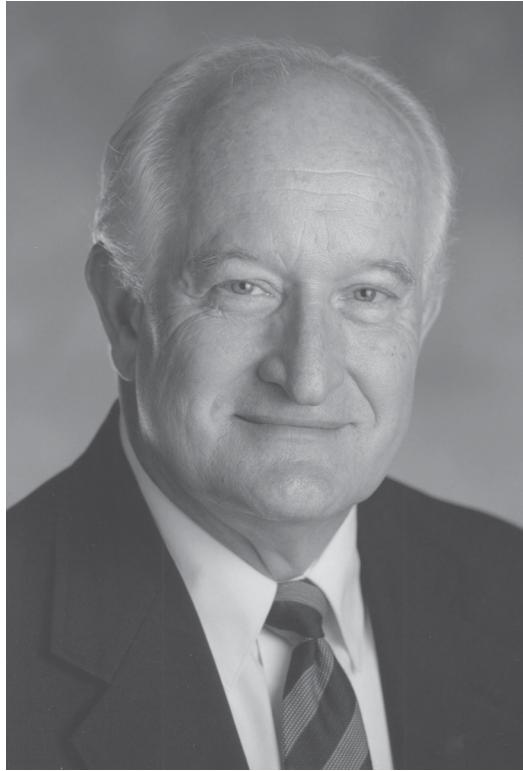
**Senior Engineering Adviser, The National Science Foundation**

Lawrence Spencer Goldberg was born in St. Louis, Missouri. He received his B.S. degree in Engineering Physics from Washington University in 1961, and his Ph.D. degree in Solid State Physics from Cornell University in 1966. From 1966-67, he spent a postdoctoral year as research assistant at the Physikalisches Institut, Universität Frankfurt, Germany. From 1967-1985, he was with the Naval Research Laboratory as research physicist in the Optical Sciences Division. During 1976-1977, he was on sabbatical leave at Imperial College, London, England. Dr. Goldberg's research interests have been in lasers, nonlinear optics, optical parametric devices, ultrashort pulse lasers and spectroscopy, liquid crystals, and radiation defect in crystals.

Dr. Goldberg came to the National Science Foundation in 1985 as Program Director for the Quantum Electronics, Waves, and Beams Program, in the Division of Electrical and Communications Systems, Directorate for Engineering. In the summer of 1989, he served as Acting Head of the NSF Office in Tokyo, Japan. His program responsibilities at NSF covered research areas of quantum electronics, optics, plasmas, and electromagnetics. He served also as Senior Staff Advisor and as Acting Division Director. In 1994, Dr. Goldberg was appointed Director of the Division of Electrical and Communications Systems and served until January 1998. Dr. Goldberg now holds the position of Senior Engineering Advisor.

Dr. Goldberg chaired the NSF coordinating committee for the Integrative Graduate Education and Research Traineeship (IGERT) program. He served under appointment by OSTP as NSF member of the Joint Management Committee for the U.S.-Japan Joint Optoelectronics Project. He currently is cognizant program officer for the Science and Technology Center on Nanobiotechnology at Cornell University, the Photonics Technology Access Program (PTAP), and the newly-established National Nanotechnology Infrastructure Network (NNIN). He also coordinates the joint NSF/SRC activity on Silicon Nanoelectronics and Beyond.

Dr. Goldberg is Fellow of the Optical Society of America, and Fellow of the Institute of Electrical and Electronic Engineers.



## Edward Wolf

**Professor Emeritus, School of Electrical and Computer Engineering, Cornell University;  
First Director, National Research and Resource Facility for Submicron Structures (now CNF)**

Prof. Wolf received his BS degree magna cum laude (chemistry, 1957) from McPherson College and the Ph.D. degree (physical chemistry, 1961) from Iowa State University. After postdoctoral studies at Princeton University (1961-62), Wolf spent fifteen years in industrial research, first at North American Science Center (1963-65) in Thousand Oaks, California, and then at Hughes Research Laboratories (1965-78) in Malibu, California, where he led one of the early efforts in scanning electron beam microfabrication. Dr. Wolf was named a Senior Scientist of the Hughes Aircraft Company in 1974.

Dr. Wolf joined the Cornell faculty in 1978 as a professor in the School of Electrical Engineering, and as the first director of the National Research and Resource Facility for Submicron Structures (NRRFSS) now the Cornell NanoScale Facility. During the 10 plus years Wolf was director, the Knight Lab was designed, built, staffed, and equipped; facility budget doubled; and the facility renamed the National Nanofabrication Facility (NNF). Dr. Wolf's research focused on chemically assisted ion beam etching and on electron and ion beam lithography. In 1983-84 Dr. Wolf teamed with Dr. John Sanford and Mr. Nelson Allen as a co-inventor of the biolistics 'gene gun' for genetic transformation using genetically coated high-velocity microscopic metal particles. In 1986, Dr. Wolf co-founded Biolistics, Inc., which developed the gene gun and associated processes. Biolistics, Inc., sold its exclusive rights to this new technology to E. I. duPont in 1990. After retirement in 1991, Wolf returned to Cornell in 1995 for two years as founding director of the Office for Technology Access and Business Assistance (COTABA).

Dr. Wolf was elected IEEE Fellow (1977) and American Institute of Chemists Fellow (1971). He served on many national and international scientific boards, committees and panels, and has authored or co-authored over two hundred fifty journal and conference papers, and has been awarded ten patents. Two versions of the biolistics gene gun are on permanent display at the Smithsonian Institution, Washington, DC, and one is in use at Epcot Research in Orlando, FL.



## Robert Buhrman

**John Edson Sweet Professor of Engineering, Applied and Engineering Physics,  
Cornell University; Director, Center for Nanoscale Systems**

Robert Buhrman received his undergraduate degree in Engineering Physics from Johns Hopkins in 1967. Later that year he enrolled in the Applied Physics graduate program at Cornell from which he was awarded the MS degree in 1970 and the Ph. D. degree in 1973. He joined the faculty of the Cornell School of Applied and Engineering Physics (A&EP) in 1973 and has remained on the faculty ever since. He currently is the J. E. Sweet Professor of Engineering.

In 1977 Buhrman was a member of the Cornell faculty team that submitted the proposal, under the leadership of ECE Prof. Joseph Ballantyne, which led to the National Science Foundation funding of the National Submicron Facility at Cornell. This facility has evolved, with continuous NSF funding, into the Cornell Nanoscale Facility. Buhrman has been a major participant in CNF for the past 25 years and currently serves as Chair of the CNF Executive Committee, which provides faculty advice and input to the CNF Director.

In 2001, Buhrman and a group of 20 other Cornell faculty members successfully prepared a proposal to the NSF in the national competition for funding for one of the initial Nanoscale Science and Engineering Centers that were being established as part of the nation's National Nanotechnology Initiative. Buhrman currently serves as Director of the resultant Center for Nanoscale Center.

Buhrman's own research interests are in the area of applied condensed-matter physics, with a current emphasis on electronic materials and devices.