

RICHARD SILBERGLITT

EDUCATION

1968 Ph.D., Solid State Physics, University of Pennsylvania
1964 M.S., Solid State Physics, University of Pennsylvania
1963 B.S. with high honor, Physics, Stevens Institute of Technology

EXPERIENCE

SENIOR PHYSICAL SCIENTIST
RAND
February 2000 – Present

Dr. Silberglitt has developed, led and contributed to RAND studies in advanced technology areas including energy, materials, manufacturing, and emerging technologies such as nanotechnology and quantum technologies for civilian, military, and intelligence agencies. He was a principal contributor to the analysis RAND performed for the National Intelligence Council (NIC)'s Global Trends 2015 study, which was published as the broadly circulated RAND monograph report, *The Global Technology Revolution* (MR-1307-NIC, 2001). He led an update of this work to analyze the impacts of converging trends in biotechnology, nanotechnology, information technology, and materials science and engineering out to 2020, in support of the NIC 2020 report, *Mapping the Global Future*. That study was published by RAND as the monograph *The Global Technology Revolution 2020, Executive Summary* (MG-450-NIC, 2006) and the accompanying technical report, *The Global Technology Revolution 2020, In Depth Analyses* (TR-303-NIC, 2006), on which he has lectured widely in the U.S. and Asia. This led to a foresight study for two development groups near Tianjin, China that were published in English and Chinese in 2009 (MG-776-TBNA/TEDA, TR-649-TBNA/TEDA, and TR-649.1-TBNA/TEDA).

Dr. Silberglitt is an active contributor to the international foresight community, having led foresight studies in the U.S., Southeast Asia, and Brazil. He served as Chair of the International Advisory Board of the APEC Center for Technology Foresight, and has lectured widely on foresight in the U.S. and abroad, including the International Foresight Academy. His work has been presented at the Technology Foresight Assessment conference of the European Commission's Joint Research Centre, and selected for publication in international foresight journals.

Dr. Silberglitt's recent foresight work includes developing and facilitating participatory foresight workshops for the National Institute for Occupational Safety and Health to analyze scenarios developed by them for the future of occupational safety and health, Culver City Forward to identify and assess possible development paths for Culver City, CA, and the Road to Zero Coalition led by the U.S. National Safety Council to develop scenarios for the U.S. to achieve a vision of zero traffic fatalities by 2050. He has taught *Technology Foresight and Public Policy* and *Participatory Foresight for Democratic Governance and Societal Change* in the Pardee RAND Graduate School.

His work in support of law enforcement includes RAND's 2014 report, *Vision of Law Enforcement Technology in the period 2024-2034*, which described the results of a futures workshop with U.S. law enforcement practitioners and academics and was presented at the 2016 Conference of the International Association of Law Enforcement Planners (IALEP) in Waterloo, Ontario, Canada in 2016, as well as RAND's 2017 report, *Wearable Technologies for Law Enforcement: Multifunctional Vest System Options*.

He has recently been an active participant in RAND's assessments of global capabilities in quantum information science and technology, including the assessment of the quantum industrial bases of the United States and China, and is co-leading studies of the potential for a "quantum winter"—a large reduction in funding for quantum computing, and of the quantum industrial bases of U.S. allies. He has led studies of critical materials for several U.S. government agencies, and testified before the U.S. Congress on this subject in 2015 and 2017 and the U.S.-China Economic and Security Review Commission in 2019.

Dr. Silbergliitt led a comprehensive study of nano-enabled technologies that culminated in an investment roadmap for a U.S. Government client. Based on these works, he contributed an encyclopedia article on nanomaterials and co-authored with RAND colleagues a chapter on biodefense for a biomedical nanotechnology volume. Dr. Silbergliitt is also the co-developer of a RAND R&D portfolio analysis and management framework ("PortMan") that was developed for the Department of Energy and has been demonstrated for the Office of Naval Research (RAND MG-271-NAVY, 2004) and has formed the basis for a RAND portfolio management initiative for the U.S. Army (MG-761-A, 2009, MG-979-A, 2011, MG-1187-A, 2012, RB-9678-A, 2012), National Security Agency, National Institute of Justice, and other agencies, as well as the development of other portfolio analysis methods for transportation technologies and technologies with game-changing potential for the Department of the Air Force. Other projects that he has led include:

- Application of patent analysis methods to identify emerging technologies and evaluate patent portfolios to identify the organizations with the earliest patent applications in emerging technological areas, which can be a sign of technological leadership.
- An analysis and identification of high-priority technology needs for first responders to fill capability gaps in emergency response operations.
- An analysis for the Director of Department of Defense Laboratories of the patent portfolios of the 60+ Defense Laboratory Enterprise laboratories that showed in which technical areas individual laboratories were leading, in sync with, or following all inventors filing patent applications in those areas.
- A study for the Office of the Deputy Assistant Secretary of Defense for Research and Engineering that developed policy options for addressing concerns associated with the dependence of soldier-portable batteries on a supply chain based in Asia.
- A study for the National Intelligence Council of supply chain issues associated with materials that are critical inputs to manufacturing that showed critical materials are not restricted to the widely publicized rare earth metals. The results were published in the RAND report, *Critical Materials: Present Danger to U.S. Manufacturing* (RR-133-NIC, 2013) and the subject of Congressional testimony in May, 2015.
- The High Temperature Superconductivity (HTS) Study in the Science and Technology Policy Institute, which analyzed the characteristics of power technologies based upon HTS and evaluated their potential to meet the demands of the evolving electric power grid, with emphasis on transmission constraints.

- A project to quantify the benefits on reliability and available transfer capacity of HTS cable substitutions in specific portions of the U.S. utility grid through contingency analyses performed using computer simulations of power flows.
- A project to identify and prioritize materials research needs to obtain the performance targets of the nine most energy-intensive industries for the U.S. Department of Energy Office of Industrial Technologies (OIT).
- A project to define the linkages between the OIT industry technical roadmaps, and programs and projects addressing research needs described in these roadmaps.
- An assessment of energy scenarios and their implications for energy policy
- A case study of Intelligent Manufacturing Systems (IMS), an industry-led international consortium

VICE PRESIDENT, MATERIALS PROCESSING/MATERIALS ADVISOR
 FM TECHNOLOGIES, INC.
 July 1993 – January 2000

Dr. Silberglitt had responsibility for conceiving, initiating, directing and executing materials R&D and technology development projects, including those aimed at the use of directed energy techniques such as microwaves and pulsed electron beams to join ceramics and ceramic composites to themselves and metals. He led a research group that explored the application of microwave processing technology to industrial applications such as the fabrication of ceramic heat exchanger and radiant burner tube assemblies, the processing of ceramic composites, and the development of microwave regenerated diesel engine particulate traps. He was also responsible for the materials aspects of projects involving coatings to increase voltage breakdown thresholds of metals, ferroelectric cathodes for high-current, high-repetition-rate electron guns, and pulsed electron beam surface modification.

Dr. Silberglitt interacted extensively with scientists, engineers and program managers in the user industries, as well as universities and National Laboratories, to identify and pursue materials technology development opportunities with the potential to improve U.S. industrial productivity.

COMPANY SENIOR SCIENTIST
 TECHNOLOGY ASSESSMENT AND TRANSFER, INC.
 March 1990 - July 1993

Dr. Silberglitt had responsibility for technical oversight and guidance of corporate R&D programs and identification and development of new R&D and technology transfer initiatives. Areas of interest included advanced coatings technology, high temperature superconductivity, oxy-acetylene torch deposition of wear-resistant diamond films, and on-demand reusable heat packs for consumer and medical applications.

Dr. Silberglitt also managed projects dealing with materials and energy technologies that have the potential to increase U.S. industrial productivity and competitiveness. This included research on the joining of ceramic materials using microwave energy, including oxides,

carbides, nitrides and composites. This research led to the development of new instrumentation and techniques for the processing of ceramics and ceramic composites with microwave heating.

SENIOR SCIENTIST/SECTION MANAGER

QUESTECH, INC.

April 1987 - March 1990

As Senior Scientist in the Office of Advanced Programs, Dr. Silbergliitt managed contract and proposal efforts and provided Red Team expertise in a wide variety of high technology areas, including energy conservation, materials science and engineering, industrial modernization, high power microwaves, and electronic warfare. He led a materials research initiative to commercialize a technique for the joining of ceramic materials using microwave energy that was developed and patented under his direction by a QuesTech subsidiary, DHR, Inc. He also provided consulting support to the Department of Energy (DOE) ECUT Program to identify, evaluate and prioritize innovative research in materials and tribology.

As Section Manager in the Intelligence and Electronic Warfare Division, Dr. Silbergliitt was responsible for a group engaged in scientific and engineering analysis of intelligence collection systems covering the entire electromagnetic spectrum, including radar, millimeter wave, optical and electro-optical devices. His staff also provided technical and management support to the U.S. Army Center for Night Vision and Electro-optics at Fort Belvoir, VA. Projects under Dr. Silbergliitt's direction ranged in value from \$250,000 to \$3 million.

SENIOR SCIENTIST/PRINCIPAL/VICE PRESIDENT

DHR, INC.

September 1977 - April 1987

As Vice President, Dr. Silbergliitt managed all energy and materials work, encompassing laboratory research, technology assessment, technology transfer, and program evaluation and support. Clients included the Department of Energy and all of its National Laboratories, as well as major private sector firms such as electric utilities and materials suppliers and developers. He was responsible for programs amounting in value to \$1.6 million. His group supported the following DOE Offices: Basic Energy Sciences, Advanced Conservation Research, Energy Conversion and Utilization Technologies, and Technical Coordination.

As Principal, Dr. Silbergliitt conceived and managed several large technology and research evaluation projects that required the coordination of technical inputs from experts in academia, industry and Government. This included a National Laboratory review of innovative research concepts aimed at achieving revolutionary advances in energy efficiency and the review and assessment of all DoD research in materials and tribology, leading to identification of energy conservation research opportunities. In addition, Dr. Silbergliitt managed detailed reviews and evaluations of materials research opportunities

and requirements for improving solar thermal and photovoltaic energy systems, which were recognized professionally through invitations to contribute chapters to the landmark MIT Press review of Solar Energy and to present a paper at the 1984 ASM Conference on Materials for Advanced Energy Systems.

As Principal and Senior Scientist, Dr. Silberglitt initiated, provided technical guidance to, and had lead corporate responsibility for technology development projects in: subsurface radar for detection and location of oil leaks in underground electric transmission lines; and daylighting of buildings using a Luminescent Solar Concentrator (LSC). A laboratory prototype of the subsurface radar was successfully field tested in New York City, and a patent was issued to QuesTech on the LSC daylighting system. Dr. Silberglitt also initiated and directed a materials research program that led to a patented technique for the joining of ceramics using microwave energy, and conducted numerous materials research evaluations, including state-of-the-art evaluations of superalloys, ceramics, and composites, and a technology transfer effort for Oak Ridge National Laboratory on long-range ordered alloys and nickel aluminides. During this time he also served on review panels for the National Bureau of Standards (now NIST) and the Solar Energy Research Institute, and presented invited papers and organized sessions at conferences sponsored by ASM, IEEE, ASME and ASCE.

SENIOR STAFF OFFICER
NATIONAL ACADEMY OF SCIENCES
January 1976 - December 1977

Dr. Silberglitt managed the Risk/Impact Panel of the Committee on Nuclear and Alternative Energy Systems, which established a data base on risks and impacts of energy production and use, chose and developed methods for comprehensive risk/impact assessment and intercomparison, and supported resource groups concerned with emissions and their health, environmental, and sociopolitical effects. He also helped the Director of this \$3 million study to coordinate and integrate the analyses of panels concerned with energy supply, demand, and econometric modeling and to construct a consistent set of energy scenarios for the 1975-2010 time frame that formed the basis for the NAS recommendations, as described in "Energy in Transition, 1985-2010," Freeman, New York (1979).

PROGRAM OFFICER
DIVISION OF MATERIALS RESEARCH
NATIONAL SCIENCE FOUNDATION
August 1971 - January 1976

As Assistant and Associate Program Director for Solid State Physics, Dr. Silberglitt directed a sponsored research program with a value of \$9M, including areas such as superconductivity, catalysis, surface science, structure of materials, and electronic and optical properties of solids. His activities encompassed proposal review (300-400 per year), materials research assessment, preparation of program planning and budgeting documentation, and decision making using an extensive peer review system drawn from

the entire condensed matter science research community. Dr. Silberglitt also conducted independent research during this time. He developed theories describing the dynamic magnetic properties of insulating ferromagnets and the effect of lattice dynamics and stoichiometry on superconductors. The latter model was applied to the tungsten bronzes, non-stoichiometric materials with a perovskite structure similar to that of the high temperature superconducting ceramic oxides. An invited paper on this work was presented at an international conference.

RESEARCH ASSOCIATE
PHYSICS DEPARTMENT
BROOKHAVEN NATIONAL LABORATORY
September 1969 - August 1971

Dr. Silberglitt performed theoretical research in magnetism and lattice dynamics. He also helped design and perform a neutron scattering experiment that verified the theory of two-spin-wave interactions in a Heisenberg-type ferromagnet. He directed the thesis research of a student at the State University of New York at Stony Brook and supervised the research of a visiting Postdoctoral Associate from Grenoble, France.

LECTURER IN PHYSICS
UNIVERSITY OF CALIFORNIA, SANTA BARBARA
August 1968 - August 1969

Dr. Silberglitt taught three courses in elementary physics and conducted theoretical research in magnetism, lattice dynamics, and Green's functions, leading to numerous publications in refereed physics journals, invited and contributed presentations at U.S. and international technical meetings, and invited seminars at over 25 universities and research institutes in the U.S. and abroad.

PROFESSIONAL AFFILIATIONS

American Physical Society
American Ceramic Society
Materials Research Society

PROFESSIONAL ACTIVITIES

Invited Lecturer, “Microwave Joining of Ceramics,” Golden Gate Materials Technology Conference, American Welding Society, February 1993
Symposium Organizer and Co-Chair, “Joining of Advanced Inorganic Materials,” Materials Research Society Spring Meeting, April 1993
Course Instructor, “Microwave Technology in Chemistry and Ceramics,” International Microwave Power Institute, July 1994 and July 1995
Symposium Organizer and Co-Chair, “Microwave Processing of Materials,” American Physical Society March Meeting, March 1995
Symposium Organizer and Co-Chair, “Microwaves: Theory and Application in Materials Processing III,” American Ceramic Society Annual Meeting, May 1995
Symposium Organizer and Co-Chair, “Emerging Technologies,” First World Congress on Microwave and RF Processing,” January 1997
Panel Member, "Applications of Superconducting Transmission & Distribution Technologies," IEEE Power Engineering Society Winter Meeting, January 2002
Guest Lecturer on “The Global Technology Revolution,” Industrial College of the Armed Forces, National Defense University, February 2002
Member of Chemical Industry Vision 2020 Nanomaterials Roadmap Team, September 2002
Speaker on “Current Issues in Energy and Nanotechnology,” 2003-2004 AAAS Science and Technology Fellows Orientation, September 2003
Member of Expert Review Panel for DOE Energy Efficiency and Renewable Energy Peer Review Guide, January 2004
Speaker on “Nanomaterials: Trends, Opportunities, and Issues,” 2004-2005 AAAS Science and Technology Fellows Orientation, September 2004
Panelist, International Forum on Technology Foresight and National Innovation Strategies, Seoul, Korea, November, 2005
Keynote Speaker, APEC Workshop on Emerging Technologies: The Global Challenges of Convergence, Bangkok, Thailand, December, 2005
Invited Speaker, Conference on Emerging Technologies—Opportunities for New Businesses, Bangkok, Thailand, December, 2005
Faculty for Nanotechnology Conclave, 2006, sponsored by the Indo-US Science and Technology Forum and the Confederation of Indian Industry, New Delhi, India, February, 2006
Invited Lecturer, 11th PDMA Strategic & Operational Portfolio Management Conference, February, 2006
Invited Lecturer, Science and Technology Policy Forum of the Korean Science and Technology Policy Institute (STEPI) “Vision 2030” Initiative, Seoul, Korea, November, 2006
Invited Speaker, Scenario Workshop, Converging Technologies to Combat Emerging Infectious Diseases (APEC-wide Foresight Project), Phang-Nga, Thailand, February, 2007

Invited Lecturer, Workshop on Future Technologies for the Warfighter, Air Command and Staff College, Maxwell AFB, AL, April, 2007

Invited Speaker, NCMS-AMT Manufacturing Technology Forum, Baltimore, MD, August, 2007

Invited Speaker and Panelist, Third International Conference on Foresight, Tokyo, Japan, November, 2007

Invited Speaker, International Conference on Emerging and Disruptive Technologies, Singapore, September, 2009

Keynote Speaker, 40th Anniversary Symposium, Returning Prosperity to America's Heartland, Northern Illinois University Center for Governmental Studies, DeKalb, Illinois, December, 2009

Invited Speaker, Symposium on Challenges and Strategies of the Future, Korean Institute for Science and Technology Evaluation and Planning (KISTEP), Seoul, Korea, August, 2010

Invited Speaker, Foresight International Seminar: From Theory to Practice, Brasilia, Brazil, December, 2010

Invited Lecturer and Focus Group Facilitator, International Focus Group Meetings on "Integrated Foresight for Sustainable Economic Development and Eco-Resilience in ASEAN Countries," Nakorn Prathom, Thailand, January, 2013; Jakarta, Indonesia and Hanoi, Vietnam, April, 2013.

Invited Lecturer, Top International Think-tank Symposium for Jiangsu Development, Nanjing, China, December, 2013.

Invited Panelist, Futures Analysis Seminar, Australian Defence College, Weston, Australia, December, 2013.

Visiting Scholar, Center for Strategic Studies and Management (CGEE), Brasilia, Brazil, June, 2014

Invited Lecturer, Technology Foresight Training: National Key Technologies and Technology Readiness Levels, Bangkok, Thailand, November, 2014.

Invited Witness, U.S. Senate Energy and Natural Resources Committee Hearing on S. 883, The American Mineral Security Act of 2015, May 12, 2015.

Invited Speaker on Law Enforcement Futures, International Association of Law Enforcement Planners (IALEP), Waterloo, Ontario, Canada, September 21, 2016.

Invited Witness, U.S. House of Representatives Committee on Natural Resources, Subcommittee on Energy and Mineral Resources Oversight Hearing, December 12, 2017.

Distinguished Visiting Fellow, S. Rajaratnam School of International Studies (RSIS), Nanyang Technological University, Singapore, April, 2018.

Invited Speaker on Policing Challenges Driven by Accelerating Technology and Evolving Society, Organization for Security and Cooperation in Europe (OSCE) Annual Police Experts Meeting (APEM), Vienna, Austria, October, 2018.

Invited Participant and Futures Group Discussion Leader, Chief of Defense Strategy Forum, Royal Air Force Club, London, England, January 2020.

Member of Advisory Board, Department of Mathematics, New Jersey Institute of Technology, Newark, NJ 1996-present.

Member of the International Advisory Board of the APEC Center for Technology Foresight, Bangkok, Thailand, 2006-2014 (Chair 2010-2014).

Professor, Pardee RAND Graduate School, 2012-present.

PATENTS

- Mako, F. M., Silbergliitt, R and Len, L. K, "Pulsed Electron Beam Joining of Materials," U. S. Patent No. 5,599,468 (February 4, 1997).
- Ahmad, I., Paquette, E.L. and Silbergliitt, R., "Microwave Energy-Assisted Chemical Vapor Infiltration," U.S. Patent No. 5,238,710 (August 24, 1993).
- Peter, W. and Silbergliitt, R., "Suppression of Voltage Breakdown and Field Emission From Surfaces," U.S. Patent Application submitted October, 1996.
- Mako, F. M. and Silbergliitt, R., "Means for Microwave Regeneration of Diesel Engine Particulate Filter," U.S. Patent Application submitted April, 1995.

PUBLICATIONS

- Silbergliitt, R., "Wearable Technologies: Potential Performance Enhancer for Law Enforcement," *RSIS Commentary*, S. Rajaratnam School of International Studies, Nanyang Technological University, Singapore (May 15, 2018).
- do Couto e Silva, Eduardo, Richard Silbergliitt, Lucas Chieregatti Machado, Jackson Max Furtunato Maia, and Cristiano Hugo Cagnin, "A Portfolio Analysis Methodology to Inform Innovation Policy and Foresight," *Technological Forecasting and Social Change* **115** (2017), pp. 338-347.
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- Silbergliitt, R. and Shawn Kimmel, "Energy Scenarios for Southeast Asia," *Technological Forecasting and Social Change* **101** (2015), pp. 251-262.
- Silbergliitt, R., "Technology Foresight, Social Equity and International Stability," in *Strategic Latency and World Power: How Technology is Changing our Concepts of Security*, Zachary Davis, Ronald Lehman and Michael Nacht, eds., Lawrence Livermore National Laboratory (2014), https://cgsr.llnl.gov/highlights/strategic_latency .
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- Silbergliitt, R., "Nanomaterials: New Trends," *Encyclopedia of Nanoscience and Nanotechnology*, Marcel Dekker, New York (2004).
- Silbergliitt, R., Hove, A., and Shulman, P., "Analysis of US Energy Scenarios: Meta-scenarios, Pathways, and Policy Implications," *Technological Forecasting and Social Change*, **70** (2003), pp 297-315.
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- Ettegui, E., Grijalva, S., Silbergliitt, R., and Wakefield, C., "Potential Impact of High Temperature Superconducting Cables on Grid Reliability and Available Transfer Capacity: Power Flow Simulation Results," IEEE Power Engineering Society Winter Meeting, January 2002, IEEE Piscataway, NJ, available on CD.
- Danko, G. A., Silbergliitt, R., Colombo, P., Pippel, E. and Woltersdorf, J., "Comparison of Microwave Hybrid and Conventional Heating of Pre-ceramic Polymers to Form Silicon

- Carbide and Silicon Oxycarbide Ceramics," *J. Am. Cer. Soc.* **83**[7] (2000), pp. 1617-1625.
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- Carim, A., Schwartz, D. and Silbergliitt, R. (eds.), "Joining and Adhesion of Advanced Inorganic Materials," MRS Symposium Proceedings, Vol. 314, Materials Research Society, Pittsburgh, PA (1993).
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- Sa'adaldin, H.S., Black, W.M., Tian, Y.-L., Ahmad, I. and Silbergliitt, R., "Microwave Heating of Ceramics in a Single Mode Mitered Bend Cavity," Ceramic Transactions, Vol. 36, (1993), pp. 359-364.
- Ahmad, I., Black, W.M., and Silbergliitt, R., "Direct Microwave Joining of Reaction Bonded Silicon Carbide," Ceramic Engineering and Science Proceedings, Vol. 13, Nos. 7-8, (1992), pp. 520-527.
- Ahmad, I., Silbergliitt, R., Black, W.M., Sa'adaldin, H.S., and Katz, J.D., "Microwave Joining of SiC Using Several Different Approaches," MRS Symposium Proceedings, Vol. 269, (1992), pp. 271-276.

- Sa'adaldin, H.S., Black, W.M., Ahmad, I. and Silbergliitt, R., "Efficient Coupling with an Adjustable Compound Iris for Joining of SiC in a Single Mode Applicator," MRS Symposium Proceedings, Vol. 269, (1992), pp.91-96.
- Silbergliitt, R., Palaith, D., Black W.M., Sa'adaldin, H.S., Katz, J.D. and Blake, R.D., "Investigation of Interlayer Materials for the Microwave Joining of SiC," Ceramic Transactions, Vol. 21, (1991), pp. 487-495.
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- Yelon, W.B., and R. Silberglitt, "Renormalization of Large Wavevector Magnons in Ferromagnetic CrBr₃ Studied by Inelastic Neutron Scattering: Spin-Wave Correlation Effects," Physical Review B4, (1971), pp. 2280-2286.
- Sivardiere, J., and R. Silberglitt, "Influence of True Crystallographic Structure on Spin Waves in Ferromagnetic CrBr₃," Physical Review B4, (1971), pp. 2236-2242.
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