Bhavik R. Bakshi

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Professional Interests

Sustainability Science and Engineering; Circular Economy; Process Systems Engineering; Complex and Multiscale Systems; Systems Ecology.

Education

1986-92	**Massachusetts Institute Of Technology**, Cambridge, MA Ph.D. in Chemical Engineering (Advisor: Prof. George Stephanopoulos)
1986-89	**Massachusetts Institute of Technology**, Cambridge, MA M.S. in Chemical Engineering Practice (MSCEP)
1982-86	**University of Bombay**, Department of Chemical Technology, Bombay, India Bachelor of Chemical Engineering (B. Chem. Eng)

Academic Experience

Jul '23-present	**Arizona State University**, Tempe, AZ Julie Ann Wrigley Professor, School for Engineering of Matter, Transport and Energy, School of Sustainability, School of Complex Adaptive Systems
Jul '23-present	**The Ohio State University**, Columbus, OH Richard M. Morrow professor emeritus of Chemical and Biomolecular Engineering
Sep '16-Jun '23	**The Ohio State University**, Columbus, OH Richard M. Morrow Professor of Chemical and Biomolecular Engineering
Oct '05-Jun '23	**The Ohio State University**, Columbus, OH Professor of Chemical and Biomolecular Engineering
Jun '20-Jun '23	OSU **Environmental Sciences Graduate Program**, Affiliated faculty
Jan '18-Dec '22	OSU **Sustainability Institute**, Faculty Advisory Board
May '21-Apr '22	**Indian Institute of Technology Delhi**, New Delhi, India VAJRA Adjunct Professor, Department of Chemical Engineering
Jan '14-'19	**The Ohio State University**, Columbus, OH Professor of Civil, Environmental and Geodetic Engineering
Feb '16-Jan '17	International Center of Sustainability, **Marmara University**, Istanbul, Turkey Advisor
Jan '14-Dec '15	**Indian Institute of Technology Bombay**, Mumbai, India Visiting Professor
May '12-May '15	**Emergent Institute**, Bengaluru, India Program Advisor
Jul '05-Jun '15	Research Director, **Center for Resilience**, Ohio State University
Jul '10-Jan '12	**TERI University**, New Delhi, India Vice Chancellor and Professor of Energy and Environment
Aug '08-Jun '10	**Institute of Chemical Technology**, Mumbai, India Professor of Chemical Engineering

Jan '08-Jun '12	**Ohio Center for Wetland and River Restoration**, OSU Affiliate
Jul '06-Jul '08	**Institute of Chemical Technology**, Mumbai, India Visiting Professor of Chemical Engineering
Oct '99-Sep '05	**The Ohio State University**, Columbus, OH Associate Professor of Chemical Engineering
Oct '93-Sep '99	**The Ohio State University**, Columbus, OH Assistant Professor of Chemical Engineering
Summer '02	**U.S. Environmental Protection Agency**, National Risk Management Research Laboratory, Cincinnati, OH National Research Council Summer Faculty Fellowship
Summer '97	**Wright-Patterson Air Force Base**, Materials Directorate, Ohio Faculty Summer Research Associate
1992-93	**Massachusetts Institute of Technology**, Cambridge, MA Post-doctoral research associate (with Prof. George Stephanopoulos, half time)
Summer '91	**MIT Summer School** Lecturer on "Expert Systems in Process Engineering".
Summer '90	**Harvard University**, John F. Kennedy School of Government, Cambridge,MA Contributed to a method for the comparative assessment of environmental hazards via multivariate statistical analysis. Studied environmental problems in India.
1987-92	**Laboratory for Intelligent Systems in Process Engineering (LISPE)**, MIT Research Assistant. Successfully applied Multiscale trend analysis and fault diagnosis methods to industrial problems from Eastman Kodak, Texaco and Du Pont.
Fall '89-'91	**Massachusetts Institute of Technology** Teaching Assistant, Integrated Chemical Engineering, Process Design Module.
Fall '86	**Massachusetts Institute of Technology** Teaching Assistant, Separation Processes, 10.32.

Industrial Experience

1992-93	**Aware, Inc.**, One Memorial Drive, Cambridge, MA Member of Technical Staff (half time) Pursued research on wavelets, artificial neural networks and pattern recognition for manufacturing problems.
Mar-Jun '87	**General Electric Company**, Selkirk and Waterford, NY Plastics Division. Improved product quality in catalyst pellet manufacturing process Silicones Division. Studied a high-intensity mixer to increase plant capacity
Jan-Mar '87	**Dow Chemical Company**, Midland, MI Tested the feasibility of a new catalyst leading to improved production. Designed a deep-tank aeration pilot plant
Summer '85	**Indian Organic Chemicals Ltd.**, Khopoli, India Gained plant experience in the production of ethanol-based chemicals. Worked on the design of azeotropic distillation columns.

Professional Recognition

Awards and Other Recognitions

Member of Science Advisory Board, 2024-27, American Council for Life Cycle Assessment

Computing in Chemical Engineering Award, 2023. Awarded by the Computing and Systems Technology division of the American Institute of Chemical Engineers.

Julie Ann Wrigley Professor, Arizona State University, 2023-present

Fellow, American Institute of Chemical Engineers, 2022

University Distinguished Scholar Award, 2022. Awarded by The Ohio State University

Clara M. and Peter L. Scott Faculty Award for Excellence in Engineering Education, 2021. Awarded by the College of Engineering, The Ohio State University

Education Leadership in LCA Award, 2020. Awarded by the American Council for Life Cycle Assessment.

Lawrence K. Cecil Award, 2019. Awarded by the Environmental Division of the American Institute of Chemical Engineers.

Education Award, 2019. Awarded by the Sustainable Engineering Forum of the American Institute of Chemical Engineers.

UAA-ICT Distinguished Alumnus Award, Institute of Chemical Technology, Mumbai, India, 2018

D. B. Robinson Distinguished Lecturer, University of Alberta, Edmonton, Alberta, Canada, October 25, 2018

Outstanding Paper Award for the paper, V. Gopalakrishnan, G. F. Grubb, B. R. Bakshi, "Biosolids Management with Net-Zero CO2 Emissions: A Techno-Ecological Synergy Design", Clean Technologies and Environmental Policies, 19, 8, 2099-2111, 2017

Chemical and Biochemical Engineering Distinguished lecture, Western University, Ontario, Canada, March 30, 2017

Richard M. Morrow Professor, The Ohio State University, September 2016 - 2023

Environmental Science and Technology *first runner-up for best paper in the Environmental Policy category for 2015* for the paper, S. S. Chopra, B. R. Bakshi, and V. Khanna. "Economic Dependence of U.S. Industrial Sectors on Animal-mediated Pollination Service". Environmental Science and Technology 49.24 (2015), pp. 14441-14451.

Research Excellence in Sustainable Engineering, 2012. Awarded by the Sustainable Engineering Forum of the American Institute of Chemical Engineers.

Lumley Research Award, 1999, 2003, 2009. Awarded by the College of Engineering, The Ohio State University.

Faculty Early Career Enhancement (CAREER) Award, 1998. Awarded by the National Science Foundation.

Ted Peterson Award, 1996. Awarded by the Computing and Systems Technology area of the American Institute of Chemical Engineers

Poster session award, third place. AIChE 1991 annual meeting, Los Angeles

P.C. Ray Award for undergraduate project in India, 1986. Awarded by the Indian Institute of Chemical Engineers

Bombay University scholarship for being first in entering class, 1982

National Merit Scholarship, Government of India, 1982.

Awards to Students

Foundations of Computer-Aided Process Design Award for Outstanding Doctoral Dissertation runner-up 2024 to Vyom Thakker

Hanwha Travel Award to Sunghoon Kim at AIChE Annual Meeting, Orlando, FL, 2023

Best paper award from the Sustainable Engineering Forum of the American Institute of Chemical Engineers, 2023, to Michael Charles

Best poster award, second place to Michael Charles from the American Indian Science and Engineering Society (AISES) National Conference, 2020

Best paper award from the Sustainable Engineering Forum of the American Institute of Chemical Engineers, 2020, to Kyuha Lee and Tapajyoti Ghosh

Leo Award for best student paper at 26th CIRP conference on Life Cycle Engineering, West Lafayette, IN, May 7-9, 2019 to Xinyu Liu and Michael Charles

National Science Foundation Graduate Research Fellowship to Michael Charles, 2017

W. David Smith Jr. best student paper award from the Computing and Systems Technology Division of the American Institute of Chemical Engineers, 2016, to Rebecca Hanes

Best paper award from the Sustainable Engineering Forum of the American Institute of Chemical Engineers, 2016, to Rebecca Hanes (declined)

Best paper award, first place from the Sustainable Engineering Forum of the American Institute of Chemical Engineers, 2014, with Shweta Singh

Best paper award, second place at the International Symposium on Sustainable Systems and Technology, Cincinnati, OH, 2013, with Rebecca Hanes and Nathan Cruze

Graduate Student Paper Award, honorable mention, AIChE Sustainable Engineering Forum, 2012, with Geoffrey Grubb

Best paper award, first place at the IEEE International Symposium on Sustainable Systems and Technology, Washington, DC, 2010, with Shweta Singh

Best poster award, first place at the IEEE International Symposium on Sustainable Systems and Technology, Washington, DC, 2010, with Shweta Singh

Best Poster Award for the paper "A Framework for Assessing the Biocomplexity of Material Use", International Input Output Meeting, Seville, Spain, 9-11 July, 2008, with Dr. Jun-Ki Choi

First Place Award, IEEE student technical paper contest to Mr. Geoffrey Grubb. IEEE International Symposium on Electronics and the Environment, San Francisco, May 2008

Third Place Award, IEEE student technical paper contest to Mr. Vikas Khanna. IEEE International Symposium on Electronics and the Environment, San Francisco, CA, May 2008

Graduate Student Paper Award, second place, AIChE Environmental Division to Jorge Hau, 2007

Graduate Student Paper Award, honorable mention, AIChE Environmental Division to Nandan Ukidwe, 2007

First Place Award, IEEE student technical paper contest to Mr. Vikas Khanna. IEEE International Symposium on Electronics and the Environment, Orlando, FL, May 2007

Graduate Student Paper Award, second place, AIChE Environmental Division to Jorge Hau, 2004

Other Recognition of Students

Gordon Research Conference on Industrial Ecology, Newry, ME, travel award to Ms. Amrita Sen, 2022

Ray travel award, Ohio State University to Vyom Thakker for travel to the 14th Process Systems Engineering Conference, Kyoto, Japan, June 19-23, 2022

Foundations of Computer Aided Process Design, Copper Mountain, CO travel award to Mr. Tapajyoti Ghosh, 2019

International Society for Industrial Ecology, Beijing, China, travel award to Mr. Kyuha Lee, 2019

International Society for Industrial Ecology, Beijing, China, travel award to Mr. Michael Charles, 2019

13th International Symposium on Process Systems Engineering, San Diego, CA travel award to Mr. Tapajyoti Ghosh, 2018

International Society for Industrial Ecology, Surrey, UK travel award to Ms. Varsha Gopalakrishnan, 2015

International Society for Industrial Ecology travel award to Ms. Rebecca Hanes, 2015

National Research Council Post-Doctoral Fellowship to Shweta Singh, 2012

Presidential Fellowship, Ohio State University to Mr. Vikas Khanna, 2008-09

Christine Mirzayan Science & Technology Policy Graduate Fellowship at the National Academies to Mr. Vikas Khanna, Summer 2007

Whitney Research Award from the Department of Statistics to Mr. Lixin Lang, 2007

Presidential Fellowship, Ohio State University to Mr. Nandan Ukidwe, 2004-05

Editorial Activities

Cambridge Prisms: Plastics, Member of Editorial Advisory board, June 2022 - present

International Journal of Sustainable Engineering, Member of Editorial Advisory board, January 2021 - present

ACS Sustainable Chemistry and Engineering, Member of Editorial Advisory Board, January 2021 - present

ACS Sustainable Chemistry and Engineering, special issue on "Circular Economy of Plastics", 2021

Computers and Chemical Engineering special issue in honor of Prof. George Stephanopoulos, guest editor, 2021

Renewable and Sustainable Energy Reviews virtual special issue on "Advanced Life-Cycle Modeling of Energy and Agroecosystems", guest editor, 2020

Frontiers of Chemical Engineering special issue on "Circular Economy in Chemical Engineering", guest editor, 2020

Journal of Industrial Ecology special issue on "Climate Adaptation and Resilience in Industrial Ecology", guest editor, 2020

Journal of Advanced Manufacturing and Processing, Member of Editorial Board, October 2018 - present

Processes, Member of Editorial Board, June 2018 - present

Sustainability, Member of Editorial Board, January 2016 - present

Frontiers in Energy Systems and Policy, Member of Editorial Board, December 2013 - present

Energy Conversion and Management, Member of Editorial Board, January 2013 - present

Journal of Environmental Accounting and Management, Member of Editorial Board, January 2013-present

Clean Technologies and Environmental Policy, Member of Editorial Board, January 2015 - 2020

Chemometrics and Intelligent Laboratory Systems, Member of Editorial Board, January 2006-2019

American Society of Civil Engineering's Journal of Energy Engineering, Associate Editor, 2007-2012.

Scientific and Government Boards and Panels

Transatlantic civil society dialogues with key policy stakeholders, TRACK-STAR, Collaboration platform between EU and US civil society organizations, Member of working group on "Circular Economy and Biodiversity", May 2021 - .

United Nations Environment Program and Society of Environmental Toxicology and Chemistry Life Cycle Initiative, flagship project on "Global guidance on environmental life cycle impact assessment indicators," Taskforce 5 on Ecosystem Services, Member of task force, September 2017 - 2020

United Nations Environment Program, International Resource Panel, 2011-2012

Confederation of Indian Industry, National Committee on Technology and R & D, 2010-2011

Earth and Sky Radio Series, Member of Science Advisory Board, 2005-2010

Association of Heating, Refrigeration and Airconditioning Engineers, Member of Technical Group on Exergy and Sustainability, January 2006

NSF Worskhop on Cyberinfrastructure in Chemical and Biological Systems, Invited participant, Washington, DC, September 2006

A Forum on Sustainability, Well Being, and Environmental Protection: What's an Agency To Do?, Member of panel on "Measurement", Washington, DC, December 2, 2005

NSF Workshop on Cyberinfrastructure, Invited participant, Philadelphia, PA, April 2004

Publications

Books

[1] B. R. Bakshi, ed. *Engineering and Ecosystems: Seeking Synergies Toward a Nature-Positive World*. Springer, 2023. ISBN: 9783031356926.

[2] B. R. Bakshi. *Sustainable Engineering: Principles and Practice*. Cambridge University Press, June 2019.

[3] B. R. Bakshi, T. G. Gutowski, and D. P. Sekulic, eds. *Thermodynamics and the Destruction of Resources*. Cambridge University Press, 2011.

Book Chapters

[1] K. Dooley, V. Thakker, B. Bakshi, M. Scholz, F. Hafsa, G. Basile, and R. Buch. "A Multidisciplinary Assessment of Innovations to Improve Grocery Bag Circularity". *14th International Symposium on Process Systems Engineering*. Ed. by Y. Yamashita and M. Kano. Vol. 49. Computer Aided Chemical Engineering. Elsevier, 2022, pp. 625–630.

[2] J. Fiksel and B. R. Bakshi. "Designing for Resilience and Sustainability: An Integrated Systems Approach". *Engineering and Ecosystems: Seeking Synergies Toward a Nature-Positive World*. Ed. by B. R. Bakshi. Springer, 2022.

[3] A. Sen, G. Stephanopoulos, and B. R. Bakshi. "Mapping Anthropogenic Carbon Mobilization through Chemical Process and Manufacturing Industries". *14th International Symposium on Process Systems Engineering*. Ed. by Y. Yamashita and M. Kano. Vol. 49. Computer Aided Chemical Engineering. Elsevier, 2022, pp. 553–558.

[4] G. Stephanopoulos, B. R. Bakshi, and G. Basile. "Reinventing the Chemicals/Materials Company: Transitioning to a Sustainable Circular Enterprise". *14th International Symposium on Process Systems Engineering*. Ed. by Y. Yamashita and M. Kano. Vol. 49. Computer Aided Chemical Engineering. Elsevier, 2022, pp. 67–72.

[5] V. Thakker and B. R. Bakshi. "Guiding innovations and Value-chain improvements using Life-cycle design for Sustainable Circular Economy". *14th International Symposium on Process Systems Engineering*. Ed. by Y. Yamashita and M. Kano. Vol. 49. Computer Aided Chemical Engineering. Elsevier, 2022, pp. 1945–1950.

[6] K. Lee and B. R. Bakshi. "Energy-Water-CO 2 Nexus of Fossil Fuel Based Power Generation". *Advances in Carbon Management Technologies*. Ed. by S. Sikdar and F. Princiotta. CRC Press, Mar. 2020, pp. 184–202.

[7] T. Ghosh, K. Lee, and B. R. Bakshi. "Integrating market models and price effects in a multiscale sustainable process design framework". *Computer Aided Chemical Engineering*. 47. Copper Mountain, CO, 2019, pp. 175–180.

[8] U. D. Shah and B. R. Bakshi. "Design and Operation of Technoecological Synergy: A NO2 Case Study". *Computer Aided Chemical Engineering*. 47. 2019, pp. 193–198.

[9] B. R. Bakshi. "Including Nature in Engineering for Innovation and Sustainability: Promise, Progress and Peril". *Computer Aided Chemical Engineering*. Ed. by M. R. Eden, M. G. Ierapetritou, and G. P. Towler. Vol. 44. Elsevier, Jan. 2018, pp. 53–62.

[10] T. Ghosh, X. Liu, and B. R. Bakshi. "Including Ecosystem Services in Sustainable Process Design across Multiple Spatial Scales". *Computer Aided Chemical Engineering*. Ed. by M. R. Eden, M. G. Ierapetritou, and G. P. Towler. Vol. 44. Elsevier, Jan. 2018, pp. 1837–1842.

[11] X. Liu and B. R. Bakshi. "Extracting Heuristics for Designing Sustainable Built Environments by Coupling Multiobjective Evolutionary Optimization and Machine Learning". *Computer Aided Chemical Engineering*. Ed. by M. R. Eden, M. G. Ierapetritou, and G. P. Towler. Vol. 44. Elsevier, Jan. 2018, pp. 2539–2544.

[12] V. Gopalakrishnan and B. R. Bakshi. "Including Nature in Engineering Decisions for Sustainability". *Encyclopedia of Sustainable Technologies*. Ed. by M. Abraham. Elsevier, 2017.

[13] B. Kursun and B. R. Bakshi. "Sustainability Assessment in a Geographical Region and of the Activities Performed". *Handbook of Research on Green Economic Development Initiatives and Strategies*. Ed. by M. M. Erdoğdu, T. Arun, and I. H. Ahmad. IGI Global, 2016. Chap. 2, pp. 18–43.

[14] R. J. Hanes and B. R. Bakshi. "Comprehensive life cycle accounting in sustainable process design". *Sustainability of Products, Processes and Supply Chains: Theory and Applications*. Ed. by F. You. Computer Aided Chemical Engineering. Elsevier, 2015.

[15] S. Singh and B. R. Bakshi. "Carbon and Nitrogen Footprints of Chemical and Manufacturing Industry Sectors". *Sustainability in the Analysis, Synthesis and Design of Chemical Engineering Processes*. Ed. by G. R. Mercado and H. Cabezas. Elsevier, 2015.

[16] S. Singh, E. L. Gibbemeyer, and B. R. Bakshi. "N Footprint and the Nexux Between C and N Footprints". *Assessing and Measuring Environmental Impact and Sustainability*. Ed. by J. J. Klemes. Elsevier, 2015.

[17] B. R. Bakshi and G. F. Grubb. "Implications of Thermodynamics for Sustainability". *Sustainability: Multidisciplinary Perspectives*. Ed. by H. Cabezas and U. Diwekar. CRC Press, 2012.

[18] V. Khanna, L. A. Merugula, and B. R. Bakshi. "Environmental Life Cycle Assessment of Polymer Nanocomposites". *Advances in Polymer Nanocomposites*. Ed. by F. Gao. Woodhead Publishing, 2012.

[19] E. Landers, R. A. Urban, and B. R. Bakshi. "Accounting for Ecosystem Services in Life Cycle Assessment and Design". *Life Cycle Assessment: A Guide for Environmentally Sustainable Products*. Ed. by M. A. Curran. Scrivener Publishing, 2012.

[20] B. R. Bakshi, A. Baral, and J. L. Hau. "Thermodynamic Methods for Resource Accounting". *Thermodynamics and the Destruction of Resources*. Ed. by B. R. Bakshi, T. G. Gutowski, and D. P. Sekulic. Cambridge University Press, 2011.

[21] B. R. Bakshi, P. K. Goel, and H. J. Kim. "Improving the Quality of Life Cycle Inventory Data by Reconciliation with the Laws of Thermodynamics". *Thermodynamics and the Destruction of Resources*. Ed. by B. R. Bakshi, T. G. Gutowski, and D. P. Sekulic. Cambridge University Press, 2011.

[22] N. U. Ukidwe and B. R. Bakshi. "Exergy and Materials Flow in Industrial and Ecological Systems". *Thermodynamics and the Destruction of Resources*. Ed. by B. R. Bakshi, T. G. Gutowski, and D. P. Sekulic. Cambridge University Press, 2011.

[23] A. Baral and B. R. Bakshi. "Comprehensive Study of Cellulosic Ethanol Using Hybrid Eco-LCA". *Biofuel and Bioenergy from Biowastes and Residues*. Ed. by S. Khanal. American Society of Civil Engineers (ASCE), Reston, Virginia, 2009.

[24] H. Chen, B. Li, B. R. Bakshi, and P. K. Goel. "Nonlinear Modeling: Linear Approaches for Nonlinear Modeling". *Comprehensive Chemometrics*. Ed. by S. Brown, B.Walczak, and R. Tauler. Elsevier, 2009.

[25] B. Li, P. K. Goel, and B. R. Bakshi. "Nonlinear Regression: Other Methods". *Comprehensive Chemometrics*. Ed. by S. Brown, B.Walczak, and R. Tauler. Elsevier, 2009.

[26] M. Seabra, B. R. Bakshi, and P. M. Saraiva. "Denoising and Signal to Noise (SNR) enhancement: Wavelet Transform and Fourier Transform". *Comprehensive Chemometrics*. Ed. by S. Brown, B.Walczak, and R. Tauler. Elsevier, 2009.

[27] N. U. Ukidwe, J. L. Hau, and B. R. Bakshi. "Thermodynamic Input-Output Analysis of Economic and Ecological Systems". *Handbook of Input-Output Economics in Industrial Ecology*. Ed. by S. Suh. Springer, 2009.

[28] V. Khanna, Y. Zhang, G. F. Grubb, B. R. Bakshi, and L. J. Lee. "Life Cycle Assessment of Carbon Nanofibres". *Nanoscience and Nanotechnology: Environmental and Health Impact*. Ed. by V. H. Grassian. John Wiley, 2008.

[29] B. R. Bakshi. "Energy". *Encyclopedia of Environment and Society*. Ed. by P. Robbins. Sage Publications, 2007.

[30] B. R. Bakshi. "Life Cycle Analysis". *Encyclopedia of Environment and Society*. Ed. by P. Robbins. Sage Publications, 2007.

[31] B. R. Bakshi. "Thermodynamics". *Encyclopedia of Environment and Society*. Ed. by P. Robbins. Sage Publications, 2007.

[32] V. Norberg-Bohm, W. C. Clark, B. Bakshi, A. Berkenkamp, S. A. Bishko, M. D. Koehler, J. A. Marrs, C. P. Nielsen, and A. Sagar. "International comparisons of environmental hazards". *Global Environmental Risk*. Ed. by J. X. Kasperson and R. E. Kasperson. Tokyo: United Nations University Press, 2001, pp. 55–147.

[33] S. Ungarala and B. R. Bakshi. "Multiscale Estimation of Linear Dynamic Systems with and without Accurate Models". *Wavelets in Signal and Image Analysis*. Ed. by A. Petrosian and F. Meyer. Kluwer Academic Publishers, 2001.

[34] B. R. Bakshi. "Multiscale Modeling and Model-Based Denoising". *Wavelets in Chemistry*. Ed. by B. Walczak. Elsevier, 2000.

[35] M. N. Nounou and B. R. Bakshi. "Multiscale Methods for Denoising and Compression". *Wavelets in Chemistry*. Ed. by B. Walczak. Elsevier, 2000.

[36] J. F. Davis, M. J. Piovoso, K. A. Hoo, and B. R. Bakshi. "Process Data Analysis and Data Interpretation". *Advances in Chemical Engineering*. Ed. by J. A. Wei. Vol. 25. Academic Press, 1999, pp. 1–103.

[37] B. R. Bakshi and G. Stephanopoulos. "Reasoning in Time; Modeling, Analysis and Pattern Recognition of Temporal Process Trends". *Paradigms of Intelligent Systems in Process Engineering*. Ed. by G. Stephanopoulos and C. Han. Academic Press, 1995.

[38] C. Han, R. Lakshmanan, B. R. Bakshi, and G. Stephanopoulos. "Non-Monotonic Reasoning: The Synthesis of Operating Procedures in Chemical Plants". *Paradigms of Intelligent Systems in Process Engineering*. Ed. by G. Stephanopoulos and C. Han. Academic Press, 1995.

[39] A. Koulouris, B. R. Bakshi, and G. Stephanopoulos. "Empirical Learning Through Neural Networks: The Wave-Net Solution". *Paradigms of Intelligent Systems in Process Engineering*. Ed. by G. Stephanopoulos and C. Han. Academic Press, 1995.

[40] U. Utojo and B. R. Bakshi. "Connections Between Artificial Neural Networks and Multivariate Statistical Methods - An Overview". *Neural Networks in Bioprocessing and Chemical Engineering*. Ed. by D. R. Baughman and Y. A. Liu. Academic Press, San Diego, CA, 1995.

[41] B. R. Bakshi, A. Koulouris, and G. Stephanopoulos. "Learning at Multiple Resolutions: Wavelets as Basis Functions in Artificial Neural Networks and Inductive Decision Trees". *Wavelet Applications in Chemical Engineering*. Ed. by R. Motard and B. Joseph. Kluwer Inc., Boston, 1994.

Journal Articles

[1] A. Kumar, H. C. Jami, B. R. Bakshi, M. Ramteke, and H. Kodamana. "An evolutionary study on technologies for polyethylene terephthalate waste recycling using natural language processing". *Computers & Chemical Engineering* (Jan. 2025), p. 109011.

[2] A. Agrawal, B. R. Bakshi, H. Kodamana, and M. Ramteke. "Multi-objective Optimization of Food-Energy-Water Nexus via Crops Land Allocation". *Computers & Chemical Engineering* (Jan. 2024), p. 108610.

[3] A. Haq, B. R. Bakshi, H. Kodamana, and M. Ramteke. "Assessing the effectiveness of improving urban air quality with solutions based on technology, nature and policy". *Sustainable Cities and Society* 110 (Sept. 2024), p. 105549.

[4] H. C. Jami, P. R. Singh, A. Kumar, B. R. Bakshi, M. Ramteke, and H. Kodamana. "CCU-Llama: A Knowledge Extraction LLM for Carbon Capture and Utilization by Mining Scientific Literature Data". *Industrial and Engineering Chemistry Research* (Oct. 2024).

[5] S. Ma, C. Zou, B. Bakshi, and L.-C. Lin. "Molecular Dynamics Simulation of Zeolite-Assisted Pyrolysis of Polystyrene: Material Selection and Mechanistic Insights". *Industrial and Engineering Chemistry Research* 63.50 (Dec. 2024), pp. 21907–21917.

[6] F. Nazemi, B. D. Fath, and B. R. Bakshi. "Ecologically inspired metrics for transitioning to a sustainable and resilient circular economy with application to multilayer plastic films". *Sustainable Production and Consumption* 49 (July 2024), pp. 606–624.

[7] F. Nazemi, B. Bakshi, J. Castro, R. Mulyana, R. Hanes, S. Mukkamala, K. Dooley, G. Basile, G. Stephanopoulos, A. Nahas, et al. "Analysis and Design for Sustainable Circularity of Barrier Films Used in Sheet Molding Composites Production". *Technology Innovation for the Circular Economy: Recycling, Remanufacturing, Design, System Analysis and Logistics* (2024), p. 365.

[8] U. Shah, J. A. Paulson, and B. R. Bakshi. "Real-time Synergies Between Homeostatic Technological and Homeorhetic Ecological Systems by Multi-scale MPC and Bayesian Optimization". *Industrial and Engineering Chemistry Research* 63.49 (Dec. 2024), pp. 21389–21403.

[9] R. Sharma, B. R. Bakshi, M. Ramteke, and H. Kodamana. "Quantifying Ecosystem Services from Trees by Using i-Tree with Low-Resolution Satellite Images". *Ecosystem Services* 67 (June 2024), p. 101611.

[10] R. Sharma, A. Haq, B. R. Bakshi, M. Ramteke, and H. Kodamana. "Designing synergies between hybrid renewable energy systems and ecosystems developed by different afforestation approaches". *Journal of Cleaner Production* 434 (Jan. 2024), p. 139804.

[11] V. Thakker and B. R. Bakshi. "Mapping the path to a net-zero chemicals industry by long-term planning with changes in technologies and climate". *AIChE Journal* 70.5 (Feb. 2024). Cover Article, e18381.

[12] Y. Xue and B. R. Bakshi. "Ecosystem Science-based Absolute Environmental Sustainability Assessment of Chemical Products with and without Climate Justice". *ACS Sustainable Chemistry and Engineering* 12.36 (Aug. 2024), pp. 13452–13463.

[13] Y. M. Aleissa and B. R. Bakshi. "Possible but Rare: Safe and Just Satisfaction of National Human Needs in Terms of Ecosystem Services". *One Earth* 6.4 (Apr. 2023), pp. 409–418.

[14] Y. M. Aleissa and B. R. Bakshi. "Simulation Tools for Net-Positive Process Design: Trees as Unit Operations for Carbon Sequestration and Air Quality Regulation". *Computers and Chemical Engineering* (Oct. 2023), p. 108455.

[15] A. Haq, R. Sharma, B. R. Bakshi, H. Kodamana, and M. Ramteke. "Forecasting sustainable power generation profiles to achieve net-zero emissions using multi-objective techno-ecological framework: A study in the context of India". *Computers and Chemical Engineering* 179 (Nov. 2023), p. 108439.

[16] A. Kumar, B. Bakshi, M. Ramteke, and H. Kodamana. "Recycle-BERT: Extracting Knowledge about Plastic Waste Recycling by Natural Language Processing". *ACS Sustainable Chemistry and Engineering* 11.32 (Aug. 2023), pp. 12123–12134.

[17] K. Lee, S. Chun, J. M. Bielicki, and B. R. Bakshi. "Spatially-explicit absolute life cycle assessment by multi-regional hybrid modeling: Computational framework". *Journal of Cleaner Production* 430 (Dec. 2023), p. 139789.

[18] S. Ma, C. Zou, T.-Y. Chen, J. Paulson, L.-C. Lin, and B. Bakshi. "Understanding Rapid PET Degradation via Reactive Molecular Dynamics Simulation and Kinetic Modeling". *Journal of Physical Chemistry, Part A* 127.35 (Aug. 2023), pp. 7323–7334.

[19] A. Sen and B. R. Bakshi. "Techno-Economic and Life Cycle Analysis of Circular Phosphorus Systems in Agriculture". *Science of the Total Environment* (Feb. 2023), p. 162016.

[20] V. Thakker and B. R. Bakshi. "Ranking Eco-innovations to Enable a Sustainable Circular Economy with Net-Zero Emissions". *ACS Sustainable Chemistry and Engineering* 11.4 (Jan. 2023), pp. 1363–1374.

[21] M. Varga, B. Csukas, S. Khanal, and B. R. Bakshi. "Lessons from the biosphere for the anthroposphere: Analysis of recycling structures of conservational measures". *Resources, Conservation and Recycling* 192 (May 2023), p. 106919.

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[47] Singh, S., and B. R. Bakshi, "Insights into Sustainability from complexity analysis of Life Cycle Networks: A case study on Gasoline and Bio-Fuel Networks," IEEE symposium on sustainable systems and technology, IEEE-ISSST, Chicago, IL, May 16-18, 2011

[48] Urban, R. A., and B. R. Bakshi, "Design of Sustainable Supply Chains Using An Input-Output Framework," IEEE symposium on sustainable systems and technology, IEEE-ISSST, Boston, MA, May 6-8, 2012

[49] Jadhao, S. B., B. R. Bakshi, and A. B. Pandit, "The Evolving Metabolism of a Developing Economy - Insight from India's Growth," IEEE symposium on sustainable systems and technology, IEEE-ISSST, Boston, MA, May 6-8, 2012

[50] Jadhao, S. B., S. Shingade, A. B. Pandit, B. R. Bakshi, "Municipal solid waste management options in India: Insight from exergy analysis," International Symposium on Sustainable Systems and Technology, Cincinnati, OH, May 15-17, 2013

[51] Gibbemeyer, E. L., B. R. Bakshi, "Eco-Synergy design: Integrating technological and ecological systems on campus for sustainability," International Symposium on Sustainable Systems and Technology, Cincinnati, OH, May 15-17, 2013

[52] Choi, J.-K., M. Pakravan, B. R. Bakshi, "Assessing the effect of combined energy policies with an input-output framework," International Symposium on Sustainable Systems and Technology, Cincinnati, OH, May 15-17, 2013

[53] Hanes, R., N. B. Cruze, P. K. Goel, B. R. Bakshi, "Allocation in LCA as an ill-posed problem: How it can be used to get your desired result and what can be done about it?" International Symposium on Sustainable Systems and Technology, Cincinnati, OH, May 15-17, 2013

[54] Hanes, R., J. Davenport, B. R. Bakshi, P. K. Goel, "The use of regression in streamlined life cycle assessment," International Symposium on Sustainable Systems and Technology, Cincinnati, OH, May 15-17, 2013

[55] Bakshi, B. R. and J. A. Paulson, "Sustainability and Industry 4.0: Obstacles and Opportunities," *2022 American Control Conference (ACC)*, 2449-2460, 2022

Other Publications

[1] Bakshi, B. R.,"Multiresolution Methods for Modeling, Analysis and Control of Chemical Process Operations", *Ph. D. Thesis*, Dept. of Chem. Engg., MIT, 1992

[2] Bakshi, B. R., K. W. Koelling, and D. L. Tomasko, "Chemical Engineering: Versatility to Address Global Challenges", *Engineering Horizons*, Spring, 1994

[3] Bakshi, B., and M. Charles, "The Role of Vegetation in Industry for Reducing Air Pollution-Related Health Risks", *SER News*, Society for Ecological Restoration, 34, 4, 8-11, 2020

Presentations

Invited Presentations

[1] Bakshi, B. R.,"Pattern-Induced Control", Fifth Annual Symposium, *LISPE-Industry Consortium*, MIT, 1991

[2] Bakshi, B. R., A. Koulouris, A., and G. Stephanopoulos,"Wave-Net: A Multi-Resolution, Hierarchical Neural Network with Localized Learning", Wavelet Seminar Series, *Department of Mathematics, Massachusetts Institute of Technology*, 1992

[3] Bakshi, B. R.,"The Integration of Computer Science Techniques for Solving Process Engineering Problems", Departmental seminar at the *Indian Institute of Technology, New Delhi*, India, August, 1993

[4] Bakshi, B. R.,"The Impact of Computer Science Techniques on Process Systems Engineering", Departmental seminar at the *Bombay University Department of Chemical Technology*, Bombay, India, August, 1993

[5] Bakshi, B. R.,"Multi-Resolution Representation and Trend Analysis", Workshop on *Wavelets in Chemical Engineering, Washington University*, St. Louis, MO, November, 1993

[6] Bakshi, B. R.,"Towards Integrated Operation of Chemical Processes", *DuPont Company*, Circleville, October, 1994

[7] Bakshi, B. R.,"Towards Integration of Measured Data Dependent Process Operation Tasks Using a Time-Frequency Representation", *Shell Development Company*, Westhollow Technical Center, Houston, March 23, 1995

[8] Bakshi, B. R.,"Wavelet Applications for Process Operation", *McMaster Advanced Control Consortium*, McMaster University, Hamilton, Ontario, April 12, 1995

[9] Bakshi, B. R.,"A Unified View of Artificial Neural Networks and Multivariate Statistical Methods for Empirical Modeling", Statistics Colloquium, *Department of Statistics, Ohio State University*, October 24, 1995, Columbus, OH

[10] Bakshi, B. R.,"Empirical Modeling by the Unification of Neural, Statistical, and Chemometric Methods", *Wright-Patterson Airforce Base, Materials Directorate*, October, 1996, Dayton, OH

[11] Davis, J. F., B. R. Bakshi, K. A. Kosanovich, and M. J. Piovoso, "Process Monitoring, Data Analysis and Data Interpretation", *International Conference on Intelligent Systems in Process Engineering*, Snowmass, CO, 1996

[12] Bakshi, B. R.,"Wavelets", *Gordon Research Conference on Statistics in Chemistry and Chemical Engineering*, discussant, Newport, Rhode Island, July 6-10, 1997

[13] Bakshi, B. R.,"Unification of Neural and Statistical Modeling Methods by Nonlinear Continuum Regression with Application to Materials Processing", *Australasia-Pacific Forum on Intelligent Processes for Manufacturing of Materials*, IPMM'97, Gold Coast, Australia, July 14-17, 1997

[14] Bakshi, B. R.,"Multiscale Analysis and Modeling of Process Operations", *Kyoto University*, Kyoto, Japan, February 1998

[15] Bakshi, B. R.,"Multiscale Analysis and Modeling of Process Operations", *Mitsubishi Chemical*, Kurashiki, Japan, February 1998

[16] Bakshi, B. R.,"Multiscale Analysis and Modeling Using Wavelets", Joint meeting of researchers from *Japan Energy, Toshiba, Nippon Steel*, Tokyo, Japan, February, 1998

[17] Bakshi, B. R.,"Multiscale Analysis and Modeling Using Wavelets", *International Chemometrics Research Meeting*, Netherlands, May 1998

[18] Bakshi, B. R.,"Advanced Techniques for Data Analysis and Empirical Modeling", *Elf Atochem*, King of Prussia, PA, June 1998

[19] Bakshi, B. R.,"Multiscale Analysis and Modeling for Efficient Process Operation", *Honeywell Hi-Spec Solutions*, Thousand Oaks, CA, May 1999

[20] Bakshi, B. R.,"Multiscale Analysis and Modeling for Efficient Process Operation", Department of Chemical Engineering, *University of California, Los Angeles*, May 1999

[21] Bakshi, B. R.,"Wavelets and Multivariate Analysis", *Gordon Research Conference on Statistics in Chemistry and Chemical Engineering*, discussant, Plymouth, NH, July 1999

[22] Bakshi, B. R.,"Incorporating Ecological Considerations in Process Systems Engineering" *NSF Workshop on Hybrid Technologies for Waste Minimization*, discussant, Breckenridge, CO, July 1999

[23] Bakshi, B. R.,"Multiscale Analysis and Modeling for Efficient Process Operation", Department of Chemical Engineering, *Washington University*, St. Louis, November 1999

[24] Bakshi, B. R., "A Thermodynamic Framework for Environmental Life Cycle Management", *Battelle Memorial Institute*, LCM group, Columbus, OH, February 2000

[25] Bakshi, B. R., "Multiscale Analysis and Modeling for Efficient Process Operation", Department of Chemical Engineering, *Cleveland State University*, Cleveland, February 2000

[26] National Academy of Engineering and German-American Academic Council Foundation, Third German-American Frontiers of Engineering Symposium, Bremen, Germany, invited attendee, April 13-15, 2000

[27] Bakshi, B. R., "A Thermodynamic Framework for Ecologically Conscious Process Systems Engineering", Plenary Talk, *7th International Symposium on Process Systems Engineering*, Keystone, CO, July 16-21, 2000

[28] Kano, M., K. Nagao, S. Hasebe, I. Hashimoto, H. Ohno, R. Strauss, and B. Bakshi, "Comparison of Statistical Process Monitoring Methods: Application to the Eastman Challenge Problem", Plenary Talk, *7th International Symposium on Process Systems Engineering*, Keystone, CO, July 16-21, 2000

[29] Bakshi, B. R., "A Thermodynamic Framework for Ecologically Conscious Process Engineering", Department of Chemical Engineering, *University of Notre Dame*, Notre Dame, IN, October 31, 2000

[30] Bakshi, B. R., "Multiscale and Bayesian Methods for Process Operation and Control", *Statistical Signal and Image Processing, Interdisciplinary Seminar Series, Ohio State University*, November 28, 2000

[31] Bakshi, B. R., "Multiscale and Bayesian Methods for Efficient Process Operation", *PSE Asia 2000*, keynote talk, Kyoto, Japan, December 6-8, 2000

[32] Bakshi, B. R., "A Thermodynamic Framework for Ecologically Conscious Process Engineering", Division Seminar Series, *U.S. Environmental Protection Agency*, Cincinnati, OH, December 12, 2000

[33] Bakshi, B. R., "An Overview of Process Systems Engineering Research - Multiscale Methods and Ecologically Conscious Process Engineering", Department of Chemical Engineering, *Ohio State University*, January 3, 2001

[34] Bakshi, B. R., "Multiscale Analysis and Modeling", LeadScope Inc., Columbus, Ohio, March 2001

[35] Aradhye, H. B., Davis, J. F., Bakshi, B. R., Ahalt, S. C., ART-2 and Multiscale ART-2 for On-Line Process Fault Diagnosis - Validation via Industrial Case Studies and Monte Carlo Simulation, *4th IFAC workshop on On-Line Fault Detection and Supervision in the Chemical Process Industries*, Keynote presentation, Jejudo Island, Korea, June 7-8, 2001

[36] Bakshi, B. R., "Exergy, Emergy and Life Cycle Assessment", Emergy seminar series, *School of Natural Resources, Ohio State University*, October 2001

[37] Bakshi, B. R., "Making the Most of Process Information - A Multiscale and Bayesian Approach", *ExxonMobil Research Center*, Fairfax, VA, October 2001

[38] Bakshi, B. R., "Making the Most of Process Information - A Multiscale and Bayesian Approach", *Center for Process Analytics and Control Technology (CPACT) conference*, April 25-26, Edinburgh, Scotland, 2002

[39] Bakshi, B. R., "Bayesian Process Modeling" and "Multiscale SPC", *Center for Process Analytics and Control Technology, University of Newcastle*, April 29, 2002, Newcastle-Upon-Tyne, England

[40] Bakshi, B. R., "Engineering Chemical Processes for Sustainability - A Thermodynamic Approach", *Ashland Chemical*, Columbus, Ohio, May 2002

[41] Bakshi, B. R., "Multiscale Statistical Process Control Using Libraries of Basis Functions", *American Statistical Association Quality & Productivity Research Conference*, IBM T. J. Watson Research Ctr., Yorktown Heights, NY, May 21-23, 2003

[42] Bakshi, B. R., "Maximum Likelihood PCA", discussant, *Gordon Conference on Statistics in Chemistry and Chemical Engineering*, Mt. Holyoke College, July 27-August 1, 2003

[43] Bakshi, B. R., "Thermodynamic Methods for Ecologically Conscious Decision Making", *Green Design Initiative, Carnegie-Mellon University*, September 9, 2003

[44] Bakshi, B. R., "Thermodynamic Methods for Sustainability", *NSF/EPA grantees meeting*, Washington DC, May, 2004

[45] Bakshi, B. R., "Industry and the Environment - Can Thermodynamics Resolve the Conflict?", Department of Chemical Engineering, *Indian Institute of Technology*, Mumbai, India, July 2004

[46] Bakshi, B. R., "Industry and the Environment - Can Thermodynamics Resolve the Conflict?", Department of Chemical Engineering, *Indian Institute of Science*, Bangalore, India, August 2004

[47] Bakshi, B. R., "Bayesian Chemometrics - Promises and Challenges", *Conference on Chemometrics and Analytical Chemistry*, Lisbon, Portugal, September 2004

[48] Bakshi, B. R., "Industry and the Environment - Can Thermodynamics Resolve the Conflict?", Department of Chemical Engineering, *University of Coimbra*, Coimbra, Portugal, September 2004

[49] Bakshi, B. R., "Industry and the Environment - Can Thermodynamics Resolve the Conflict?", Department of Chemical Engineering, *Mumbai University Institute of Chemical Technology*, Mumbai, India, January 2005

[50] Bakshi, B. R., "Reducing Information Waste in Process Systems Engineering via Bayesian Statistics", Department of Chemical Engineering, *Carnegie Mellon University*, Pittsburgh, PA, February 2005

[51] Bakshi, B. R., "Industry and the Environment - Can Thermodynamics Resolve the Conflict?", Department of Chemical and Biomolecular Engineering, *Georgia Institute of Technology*, Atlanta, GA, February 2005

[52] Bakshi, B. R., "Reducing Information Waste in Process Systems Engineering via Bayesian Statistics", Center for Process Systems Engineering, Department of Chemical Engineering, *Georgia Institute of Technology*, Atlanta, GA, February 2005

[53] Bakshi, B. R., "Application of Statistics to Multiscale Systems", discussant for talk by Richard Braatz, *Gordon Research Conference on Statistics in Chemistry and Chemical Engineering*, Mt. Holyoke College, Holyoke, MA, July 2005

[54] Bakshi, B. R., "Technology and Sustainable Development - Implications for Developing Countries", *International Symposium on Energy Analysis and Systematic Methods for Sustainable Development*, EAFIT University, Medellín, Colombia, August 3-5, 2005

[55] Bakshi, B. R., "Thermodynamic Methods for Sustainable Engineering", *International Symposium on Energy Analysis and Systematic Methods for Sustainable Development*, EAFIT University, Medellín, Colombia, August 3-5, 2005

[56] Rawlings, J. B., and B. R. Bakshi, "Particle Filtering and Moving Horizon Estimation", *Chemical Process Control: CPC-7*, Lake Louise, Alberta, Canada, January 2006

[57] Bakshi, B. R., "Can Technology Lead to Sustainable Development? A Thermodynamic View", Department of Geological Sciences, Ohio State University, Columbus, OH, February, 2006

[58] Bakshi, B. R., "Exergy and Natural Capital", invited lecture in course on Environmentally Benign Manufacturing (2.83/2.813), Massachusetts Institute of Technology, Cambridge, MA, March 2006

[59] Bakshi, B. R., "Can Technology Lead to Sustainable Development? A Thermodynamic View", Department of Chemical and Biomolecular Engineering, Ohio State University, Columbus, OH, May, 2006

[60] Bakshi, B. R., "Thermodynamics and Industrial Ecology", Gordon Research Conference on Industrial Ecology, Oxford, U.K., August 8-11, 2006

[61] Bakshi, B. R., "Ecologically-Based Life Cycle Assessment for Environmentally Conscious Decisions", Center for Urban and Regional Analysis 2007 Interdisciplinary Roundtable Discussions, Ohio State University, October, 2007

[62] Bakshi, B. R., "The Role of Natural Capital in Sustaining a Biofuels Infrastructure", Symposium on Energy Systems Modeling, Ohio State University, December 2007

[63] Bakshi, B. R., "Introduction to Emergy and System Models", Symposium on Sustaining the Flow of Wealth in Northeast Minnesota, University of Minnesota Duluth, April 22- 24, 2008

[64] Bakshi, B. R., "Thermodynamics and Sustainable Engineering", Department of Earth and Environmental Engineering, Columbia University, New York, NY, September 2008

[65] Bakshi, B. R., "Rethinking Emergy", Workshop on Solutions to Community Sustainability, University of Minnesota Duluth, November 13-14, 2008

[66] Bakshi, B. R., "The Quest for Sustainability - An Essential Role for Process Systems Engineering", Department of Chemical and Biological Engineering, Northwestern University, Evanston, IL, December, 2008

[67] Bakshi, B. R., "Ecologically-Based Life Cycle Assessment and Design," U.S. Business Council for Sustainable Development Spring Meeting, Austin, TX, April 2009

[68] Bakshi, B. R., R. A. Urban, A. Baral, G. F. Grubb, and W. J. Mitsch, "Toward Sustainability via Design of Integrated Industrial-Ecological Systems", Foundations of Computer Aided Process Design, July, 2009

[69] Bakshi, B. R., "Assessing the Greenness of Green Chemistry", Symposium on Sustainable Chemistry for Societal Benefit organized by the Royal Society of Chemistry, Western India, SIES College, Sion, Mumbai, September, 2009

[70] Bakshi, B. R., S. Singh, R. A. Urban, "Accounting for the Role of Ecosystem Services in Life Cycle Assessment and Design," World Resources Institute Business and Ecosystem Services Group, Atlanta, GA, October 9, 2009

[71] Bakshi, B. R., "Sustainable Business Decision Making: A Thermodynamic and Ecological View", TERI University, Delhi, India, October, 2009

[72] Bakshi, B. R., "Accounting for Ecosystem Services in LCA", Life Cycle Aspects of Nanoproducts, Nanostructured Materials, and Nanomanufacturing: Problem Definitions, Data Gaps, and Research Needs, Chicago, Illinois, November 5-6, 2009

[73] Bakshi, B. R., "Life Cycle Ecological Footprint Assessment for Sustainable Products", Society of Business and Engineering, The Ohio State University, Columbus, Ohio, November 7, 2009

[74] Bakshi, B. R., "Ecosystem Services and Sustainable Engineering", Ecosystem Services Seminar Series, U.S. Environmental Protection Agency, Cicinnati, Ohio, November 19, 2009

[75] Bakshi, B. R., "Eco-LCA – Accounting for the Role of Ecosystem Services in Life Cycle Assessment", U.S. Environmental Protection Agency, Oregon, March 4, 2010

[76] Bakshi, B. R., K. Sikdar, "WBCSD Ecosystem Valuation Initiative - Analytic Model," U.S. Business Council for Sustainable Development Spring Meeting, Austin, TX, April 20, 2010

[77] Bakshi, B. R., "Ecosystem Services and Business Decision Making," Business Sustainability Roundtable Ecosystem Services Working Group Webinar, April 29, 2010

[78] Bakshi, B. R., "Ecosystem Services and Sustainability of the Chemical Industry," keynote lecture, Second International Symposium on Sustainable Chemical Product and Process Engienering, Hangzhou, China, May 9-12, 2010

[79] Bakshi, B. R., "Greening the Integrated Decision-Making Hierarchy - Challenges and Opportunities," 2010 McMaster Advanced Control Consortium (MACC) Meeting & Workshop, McMaster University, Hamilton, ON, May 19, 2010

[80] Bakshi, B. R., "Boom or Bust - Will Nanotechnology Live Up to Its Hype?," Sci-Tech Seminars, U.S. Environmental Protection Agency, Region 5 Science and Technology Council, Chicago, IL, June 9, 2010

[81] Bakshi, B. R., "Solar, Nuclear, Nano, Bio, Carbon Trading, or Something Else? Which Way to the Era of Sustainability?," UDCT Alumni Association, Institute of Chemical Technology, Mumbai, India, August 7, 2010

[82] Bakshi, B. R., P. K. Goel, "Sustainability Science and Engineering - Challenges for Chemometrics," Chemometrics and Analytical Chemistry conference, CAC 2010, Antwerp, Belgium, October 19-21, 2010

[83] Bakshi, B. R., "Sustainability Science and Engineering," Indo-US Workshop on Energy and Environmental Security, Surajkund, Delhi, India, December 11-15, 2010

[84] Bakshi, B. R., "Sustainability Science and Engineering," Gujarat Chemicals Association, Global Summit, Ahmedabad, India, December 17, 2010

[85] Bakshi, B. R., "Systems Thinking for Sustainability," plenary talk in session on Concepts and Insights on Sustainability, YUVA meet, New Delhi, India, February 1, 2011

[86] Bakshi, B. R., "Knowledge Institutions: Bringing about a Paradigm Shift," member of panel discussion at Delhi Sustainable Development Summit, New Delhi, India, February 4, 2011

[87] Bakshi, B. R., "Systems Analysis and Modeling for Cleaner Technologies," Indian Institute of Technology, Roorkee, Training Program on Cleaner Technologies, February 23, 2011

[88] Bakshi, B. R., "Sustainable Energy - Which Way to the Promised Land?" Indian Institute of Chemical Engineers, Energy Options for India, Mumbai, India, March 18, 2011

[89] Bakshi, B. R., "Sustainability Science and Engineering," INSPIRE Leadership Program, Miranda House, Delhi University, New Delhi, India, July 11-15, 2011

[90] Bakshi, B. R., "The Role of Engineering in Sustainable Development," Indian Institute of Technology, Jodhpur, Rajasthan, India, August 10, 2011

[91] Bakshi, B. R., "Accounting for Ecosystem Services in Business Decision Making," American Institute of Chemical Engineers, Sustainable Engineering Forum Webinar, August 10, 2011

[92] Bakshi, B. R., "Looking Beyond the Corporation for Energy Sustainability" Technology Review Business Impact Series on Corporate Energy Strategy, Mumbai, September 22, 2011

[93] Bakshi, B. R., "Energy Efficiency, Management, and Evaluation of Alternatives" keynote presentation, Eaton Corporation, India Technology Workshop, Pune, India, October 4, 2011

[94] Kursun, B., S. Ramkumar, B. R. Bakshi, and L.-S. Fan, "Coal Gasification by Conventional Versus Calcium Looping Process – A Life Cycle Energy, Global Warming, Land Use and Water Assessment" Sustainable Energy Plenary, American Institute of Chemical Engineers Annual Meeting, Minneapolis, October 18, 2011

[95] Bakshi, B. R., "Designing Sustainable Habitats as Networks of Technological and Ecological Systems" keynote talk, Society for Preservation of Healthy Environment and Ecology and Heritage of Agra, December, 2011

[96] Bakshi, B. R., "Business and the Environment" ITC Business Leadership Programme, Hyderabad, India, November 21, 2011

[97] Bakshi, B. R., "Nature-Inspired Networks for Sustainable Chemistry" invited presentation, Indo US workshop on Green Chemistry for Environments and Sustainable Development, HNB Garhwal University, Srinagar, Uttarkhand, India, March 11-13, 2012

[98] Bakshi, B. R., "Accounting for Ecosystem Services in Engineering Decisions" Food Agricultural and Biological Engineering Departmental Seminar Series, The Ohio State University, Columbus, OH, April 10, 2012

[99] Bakshi, B. R., "Learning from Nature for Sustainability of Technological Systems" Department of Geography, Seminar Series: Human Dimensions of Global Change, University of Maryland, College Park, MD, May 10, 2012

[100] Bakshi, B. R., "Toward Sustainable Biofuels via Networks of Technological and Ecological Systems," invited talk at V International Congress on Biofuels Science and Technology, CIBSCOL 2012, June 5-8, Bucaramanga, Colombia

[101] Bakshi, B. R., "Seeking Synergy Between Technological and Ecological Systems for Sustainable Engineering," Department of Chemical and Biological Engineering Seminar Series, Tufts University, Medford, MA, January 23, 2013

[102] Bakshi, B. R., "Seeking Synergy Between Technological and Ecological Systems for Sustainable Engineering," Department of Chemical Engineering Seminar Series, Carnegie Mellon University, Pittsburgh, PA, March 26, 2013

[103] Bakshi, B. R., R. A. Urban, "Techno-Ecological Synergy: A Framework for the Analysis and Design of Sustainable Systems," Sustainable Chemical Product and Process Engineering, SCPPE, Dalian, China, May 27-30, 2013

[104] Bakshi, B. R., "Seeking Synergy Between Technological and Ecological Systems for Sustainable Engineering," Department of Chemical Engineering Seminar Series, Indian Institute of Technology Bombay, Mumbai, India, August 1, 2013

[105] Bakshi, B. R., "Seeking Synergy Between Technological and Ecological Systems for Sustainable Engineering," Sustainability@Wayne Seminar Series, Wayne State University, Detroit, MI, September 17, 2013

[106] Bakshi, B. R., "Ecologically-Based Life Cycle Assessment and Design for Sustainability," SESYNC Workshop: Linking local consumption to global impact, NSF Socio-Environmental Synthesis Center, Annapolis, MD, December 11-13, 2013

[107] Bakshi, B. R., Gibbemeyer, E. L., Urban, R. A., "Seeking Synergies Between Buildings and Surrounding Ecosystems for a Sustainable Built Environment," US-Israel workshop on multiscale design and construction of sustainable built environments, Tel Aviv, Israel, March 10-12, 2014

[108] Bakshi, B. R., R. J. Hanes, "Sustainable Process Design by Hybrid Techno-Economic Models," China-US NSF workshop on Sustainable Manufacturing, Wuhan, China, March 13-15, 2014

[109] Bakshi, B. R., V. Gopalakrishnan, G. Ziv and M. D. Lepech, "Seeking Synergy between Technological and Ecological Systems for Sustainability," SusTech Summit, 2014, Design of Sustainable Chemical Technologies, University of California, Santa Barbara, October 1, 2014

[110] Bakshi, B. R., "Sustainability Science and Engineering" Engineers for a Sustainable World, Midwestern Regional Conference, Ohio State University, October 11, 2014

[111] Bakshi, B. R., "Techno-Ecological Synergy - A Framework for Sustainable Engineering," Workshop on Linking Local Consumption to Global Impacts, NSF Socio-Environmental Synthesis Center, SESYNC, Annapolis, MD, December 10-12, 2014

[112] Bakshi, B. R., "From Process to Planet: A Framework for Preventing Unintended Harm and Encouraging Synergies with Nature," Bren School of Environmental Management, University of California, Santa Barbara, February 10, 2015

[113] Bakshi, B. R., "Process to Planet: A Framework for Preventing Unintended Harm and Encouraging Synergies with Nature," Department of Chemical and Biological Engineering, Northwestern University, Evanston, Illinois, April 2, 2015

[114] Bakshi, B. R., "Process to Planet: A Framework for Preventing Unintended Harm and Encouraging Synergies with Nature," Process Systems Engineering Group, Department of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, MA, June 15, 2015

[115] Bakshi, B. R., "Toward Sustainable Engineering by Designing Innovative Techno-Ecological Synergies from Process to Planetary Scales," keynote presentation, Energy Systems and Sustainability, 65*th* Canadian Chemical Engineering Conference, Calgary, October 4-7, 2015

[116] Bogra, S., B. R. Bakshi, R. Mathur, "Water Footprint of Indian Economic Sectors" BRICS University President Summit, Beijing Normal University, Beijing, China, October 17-20, 2015

[117] Bakshi, B. R., "Preventing Unintended Harm and Developing Synergies with Nature: Steps Toward Sustainable Engineering," Department of Chemical Engineering, Massachusetts Institute of Technology, Cambridge, MA, October 30, 2015

[118] Bakshi, B. R., "Including Nature in Engineering for Innovation and Sustainability," Ecological and Environmental Engineering, Purdue University, West Lafayette, IN, February 10, 2016

[119] Bakshi, B. R., "Encouraging Synergies Between Human and Natural Systems: An Essential Step Toward Sustainability," Department of Food, Agriculture and Biological Engineering, Ohio State University, Columbus, OH, February 16, 2016

[120] Bakshi, B. R., "Including Nature in Engineering for Innovation and Sustainability," Plenary talk at Congress of the Mexican Academy of Research and Teaching in Chemical Engineering (AMIDIQ), Puerto Vallarta, Mexico, May 3-6, 2016

[121] Bakshi, B. R., "Including Nature in Human Decisions for Innovation and Sustainability in the Anthropocene," Trottier Institute for Sustainability in Engineering and Design McGill University, Montreal, Canada, May 9, 2016

[122] Bakshi, B. R., "Developing Synergies with Nature from Process to Planetary Scales - A Path Toward Sustainable Chemical Manufacturing," Mini-symposium on Modeling and Optimization of Chemical Processing and Reaction Systems, Kazan, Russia, May 23-26, 2016

[123] Gopalakrishnan, V., X. Liu, G. Ziv, and B. R. Bakshi, "Net Positive Impact Manufacturing by Integrated Design of Chemical Processes and Supporting Ecosystems," keynote talk at the Fourth International Conference on Sustainable Chemical Product and Process Engineering, SCPPE 2016, Nanjing, China, May 31-June 3, 2016

[124] Bakshi, B. R., "Including Ecosystem Services for Developing Innovative Processes and Life Cycles," Process Development Symposium, American Institute of Chemical Engineers, Providence, Rhode Island, June 7-9, 2016

[125] Gopalakrishnan, V., X. Liu, G. Ziv, and B. R. Bakshi, "Developing Synergies Between Ecological and Engineering Systems at Multiple Scales - Opportunities and Obstacles," The 5-th International Congress on Sustainability Science and Engineering, ICOSSE 2016, Suzhou, China, October 24-27, 2016

[126] Bakshi, B. R., "Sustainable Engineering - Challenges and Opportunities for Process Operation and Control," Foundations of Computer Aided Process Operation / Chemical Process Control, FOCAPO/CPC, January 8-12, Tucson, AZ, 2017

[127] Bakshi, B. R., "Innovation and Sustainability by Seeking Synergies with Nature," *CBE Distinguished Lecture*, Western University, London, Ontario, Canada, March 30, 2017

[128] Bakshi, B. R., "Mad Max, Star Trek, Big Brother, or Ecotopia: The Role of PSE in Enabling Future Scenarios," 2040 Visions of Process Systems Engineering, A symposium in honor of George Stephanopoulos' $70th$ birthday and retirement, June 1-2, 2017

[129] Bakshi, B. R., "Natural and Human Systems in the Circular Economy," U.S. Business Council for Sustainable Development, "Expanding the Circle" Columbus, Ohio, July 18-19, 2017

[130] Bakshi, B. R., "Sustainability of Earth and Water Resources from Ecological Perspective" One Day Symposium on Science and Engineering for Sustainable Development, Indian Institute of Technology, Mumbai, July 26, 2017

[131] Bakshi, B. R., "Enabling a Circular and Sustainable Economy: What Can We Learn from Traditional Societies" Computer Aided Process Engineering (CAPE) forum, Athens, Greece, September 6-8, 2017

[132] Bakshi, B. R., "Including Ecosystems in Engineering: Opportunities for Innovation from Process to Planet," Dow Chemical sustainability network webinar, October 11, 2017

[133] Bakshi, B. R., "Ecosystem Services in Life Cycle Assessment," Energy Systems Analysis, Argonne National Laboratory, March 1, 2018

[134] Bakshi, B. R., "Meeting the Challenges of Water Sustainability by Expanding the Boundaries of PSE," Future Innovation in Process Systems Engineering, Chalkidiki, Greece, June, 25-27, 2018

[135] Bakshi, B. R., "Including Nature in Engineering for Innovation and Sustainability: Promise, Progress and Peril," keynote talk, 13th International Symposium on Process Systems Engineering, San Diego, CA, July 1-5, 2018

[136] Bakshi, B. R., "Accounting for Ecosystems Can Help Improve the Food-Energy-Water Nexus," keynote talk, International Congress on Sustainability Science and Engineering, Cincinnati, OH, August 12-15, 2018

[137] Bakshi, B. R., "Including Nature in Engineering for Sustainability and Innovation," D. B. Robinson distinguished speaker, University of Alberta, Edmonton, AB, Canada, October 25, 2018

[138] Bakshi, B. R., "Shifting the Engineering Paradigm to Contribute to Sustainable Development," Department of Food Science and Technology, The Ohio State University, November 14, 2018

[139] Thakker, V., B. R. Bakshi, "Circular Economy for Plastics – Review and Prognosis," International Symposium on Circular Economy for Plastics, Indian Institute of Technology, Mumbai, India, March 15, 2019

[140] Bakshi, B. R., U. Shah, M. Charles, "Toward Sustainable Manufacturing Sites by Designing Synergies between the Homeostasis of Technology and the Homeorhesis of Ecosystems" keynote talk, 5th International Conference on Sustainable Chemical Product and Process Engineering, Tianjin, China June 30 - July 3, 2019

[141] Bakshi, B. R., "Engineering, Ecology, Economics: A Necessary Convergence for Sustainable Development" invited talk, Foundations of Computer Aided Process Design, Copper Mountain, Colorado, July 14-18, 2019

[142] Bakshi, B. R., "Enhancing Resilience by Techno-Ecological Synergies", Trans-Atlantic Research and Development Interchange on Sustainability (TARDIS), Estes Park, CO, Sep 9-11, 2019

[143] Bakshi, B. R., "Advancing LCA to Enable Sustainable Development: Accounting for Ecological and Economic Systems and Systematic Network Design" ExxonMobil Research and Engineering, Annandale, New Jersey, September 16, 2019

[144] Bakshi, B. R., "Technologies for Sustainable Development: How can Engineering Deliver?" Department of Chemical Engineering, Arizona State University, Tempe, AZ, October 28, 2019

[145] Bakshi, B. R., "Education for Enabling Sustainable Development: Role of Chemical Engineering and of the Campus as a Living Laboratory" Plenary talk, Sustainable Engineering Forum, AIChE Annual Meeting, Orlando, Florida, Nov 13, 2019

[146] Bakshi, B. R., "Time for a Paradigm Shift: Toward an Engineering that Accounts for People and the Planet" Lawrence K. Cecil award lecture, AIChE Annual Meeting, Orlando, Florida, Nov 11, 2019

[147] Bakshi, B. R., "Technologies for Sustainable Development: How can Engineering Deliver?" Webinar in the Distinguished Seminar Series, Department of Chemical Engineering, Imperial College, London, April 29, 2020

[148] Bakshi, B. R., "Recovery from COVID-19 Requires Sustainability, Resilience, and Respect for Nature" Panel Discussion at 15th Sustainability Summit of the Confederation of Indian Industry, September 9, 2020

[149] Bakshi, B. R., "Technologies for Sustainable Development: How can Engineering Deliver?" Webinar at the University of Celaya, Mexico, January 22, 2021

[150] Bakshi, B. R., "Technologies for Sustainable Development: How can Engineering Deliver?" Webinar at the Department of Engineering Science, Oxford University, UK, March 2, 2021

[151] Bakshi, B. R., "Toward Net-Positive Chemical Engineering by Designing for Circularity, Synergy with Nature, and Profitability" Plenary Lecture, The 30th Thai Institute of Chemical Engineering and Applied Chemistry Conference (TIChE2021), May 6, 2021

[152] G. Stephanopoulos, B. R. Bakshi, G. Basile, "Reinventing the Chemical/Materials Company: Transitioning to a Sustainable Circular Enterprise", plenary talk, Sustainable Engineering Forum, American Institute of Chemical Engineers Annual Meeting, November 7-11, 2021, Boston, MA

[153] Bakshi, B. R., "Engineering for Sustainability by Learning from and Seeking Synergies with Nature" Webinar at Environmental Change Initiative, University of Notre Dame, December 1, 2021

[154] Bakshi, B. R., "From the Bhopal Disaster to Sustainable Engineering: Some Insights from my Journey", Webinar to Vortex 9.0, Masterclass Lecture Series, Institute of Chemical Technology, Mumbai, January 25, 2022

[155] Bakshi, B. R., "Reinventing the Chemicals and Materials Industry for a Net-Zero, Nature-Positive World", Julie Ann Wrigley Global Futures Laboratory, Arizona State University, February 21, 2022

[156] Bakshi, B. R., "Reinventing the Chemicals and Materials Industry for a Net-Zero, Nature-Positive World", Keynote talk, 50th Chemical Engineering Days, Veszprém, Hungary, April 26-28, 2022

[157] Bakshi, B. R., "Toward Sustainability by Learning from and Seeking Synergies with Nature", Hungarian University of Agriculture and Life Sciences, Gödölő, Hungary, April 27, 2022

[158] Bakshi, B. R., "Towards Harmony between Industrial and Ecological Systems: Opportunities for Advanced Control", invited keynote, 7th International Symposium on Advanced Control of Industrial Processes (AdCONIP), UBC Vancouver, August 7-9, 2022

[159] Bakshi, B. R., "Net-Zero, Nature-Positive and Socially Just: Opportunities for Sustainable Engineering", Trans-Atlantic Research and Development Interchange on Sustainability (TARDIS), University of Miskolc, Miskolc, Hungary, September 14-16, 2022

[160] Bakshi, B. R., "A Sustainable Transition to a Carbon-Neutral Chemical Industry", Computing in Engineering Forum, University of Wisconsin-Madison, virtual, September 20-21, 2022

[161] Bakshi, B. R., "Reinventing the Chemicals and Materials Industry for a Net-Zero, Nature-Positive World", Energy Systems Initiative, Center for Advanced Process Descision-making, Carnegie-Mellon University, October 12, 2022

[162] Bakshi, B. R., C. Maravelias, "Systems Engineering for Sustainability in a Globalized World: Resources, Ecosystems, Boundaries", keynote talk, Foundations of Computer-Aided Process Operation -Chemical Process Control, San Antonio, TX, January 8-12, 2023

[163] Bakshi, B. R., "Engineering for a Net-Zero, Nature-Positive World", Sustainability Forum, University of Oklahoma, January 28, 2023

[164] Thakker, V., Sen, A., Stephanopoulos, G., Bakshi, B. R., "Evaluating the potential of current and emerging alternatives to enable a Sustainable Circular Economy," keynote talk, European Syposium on Computer-Aided Process Engineering, ESCAPE-33, Athens, Greece, June 18-21, 2023

[165] Bakshi, B. R., "Reinventing the Chemicals and Materials Industry for a Net-Zero, Nature-Positive Future", School for Engineering of Matter, Transport and Energy, Arizona State University, Sep 15, 2023

[166] Bakshi, B. R., "Reinventing the Chemicals and Materials Industry for a Net-Zero, Nature-Positive Future", Department of Food, Agricultural and Biological Engineering, The Ohio State University, Sep 19, 2023

[167] Bakshi, B. R., "Process Systems Engineering for People and the Planet: A Personal Journey", Computing in Chemical Engineering award lecture, CAST dinner banquet, AIChE Annual Meeting, Orlando, November 7, 2023

[168] Bakshi, B. R., "Recent Developments in Sustainable Engineering", Sustainability Forum 2024: The Energy and Materials Nexus, University of Oklahoma, January 27, 2024

[169] Bakshi, B. R., "Choosing the Best Technologies to Combat Climate Change", MIT Club of Northern California, virtual fireside chat, February 1, 2024

[170] Bakshi, B. R., "Systems Perspective for Implementing the Circular Economy for Polymers", American Chemical Society, Spring meeting, New Orleans, LA, March 20, 2024

[171] Bakshi, B. R., "Reinventing the Chemicals and Materials Industry for a Net-Zero, Nature-Positive Future", Department of Chemical and Biological Engineering, University at Buffalo, Buffalo, NY, March 27, 2024

[172] Bakshi, B. R., "Reinventing the Chemicals and Materials Industry for a Net-Zero, Nature-Positive Future", Frontiers of Technology, Chevron Phillips Chemical, Kingwood, TX, April 4, 2024

[173] Bakshi, B. R., "Reinventing the Chemicals and Materials Industry for a Net-Zero, Nature-Positive World", School of Chemical Engineering, Oklahoma State University, April 23, 2024

[174] Bakshi, B. R., "The Future of Process Systems Engineering is Sustainability", Americal Institute of Chemical Engineers, Computing and Systems Technology division webinar, May 7, 2024

[175] Bakshi, B. R., "Designing Process Systems for Net-Zero Emissions and Nature- and People-Positive Decisions", Foundations of Computer Aided Process Design, Breckenridge, CO, July 14-18, 2024

[176] Bakshi, B. R., "Process Systems Engineering and Data Science for Sustainable Transformation of the Chemicals and Materials Industry to Net-Zero Emissions", Industrial Ecology and Data Science for Sustainable Manufacturing in India, Indian Institute of Technology Madras, December 12-13, 2024

Additional Paper Presentations

[1] Stephanopoulos, G., B. Bakshi, and J. Cheung,"Analysis of Operating Trends and Its Impact on the Design of Neural Networks", *AIChE 1990 Annual Meeting*, Chicago, IL

[2] Bakshi, B. R., J. T.-Y. Cheung, and G. Stephanopoulos,"Multi-Scale Analysis of Process Trends", *Instrument Society of America Annual Conference*, Anaheim, CA, 1991

[3] Stephanopoulos, G., J. Carrier, and B. Bakshi,"Generation/Validation of Models for the Design of Process Controllers", *AIChE 1991 Annual Meeting*, Los Angeles, CA

[4] Bakshi, B. R., and G. Stephanopoulos, "Wave-Nets: A Novel Method for Hierarchical, Multiresolution, Localized Learning in Neural Networks", poster at the *AIChE 1991 Annual Meeting*, Los Angeles, CA

[5] Bakshi, B. R., and G. Stephanopoulos, Wave-Net: A Multi-Resolution, Hierarchical Neural Network with Localized Learning, *International Symposium on New Trends in Neural Networks*, University of Ghent, Belgium, 1992

[6] Koulouris, A., B. R. Bakshi, and G. Stephanopoulos,"Modeling and Characterization of Nonlinear Systems Using Wave-Nets", *AIChE 1992 Annual Meeting*, Miami Beach

[7] Bakshi, B. R., and G. Stephanopoulos,"Wave-Net: A Wavelet-Based Connectionist Network for Process Monitoring and Control", *AIChE 1992 Annual Meeting*, Miami Beach

[8] Bakshi, B. R., P. Jiang, L.-S. Fan,"Analysis of Circulating Fluidized Beds Using Multi-Resolution Methods", *AIChE 1994 Annual Meeting*, San Francisco

[9] Bakshi, B. R.,"Efficient Storage and Retrieval of Measured Data for Improved Process Operation and Control", *AIChE 1994 Annual Meeting*, San Francisco

[10] Utojo, U., and B. R. Bakshi,"Empirical Modeling by the Unification of Neural and Statistical Projection-Based Methods", *AIChE 1995 Annual Meeting*, Miami Beach, FL

[11] Bakshi, B. R., P. Bansal, and H. Zhong,"Integration of Data Rectification, Compression and Empirical Modeling Methods Using a Time-Frequency Representation", *AIChE 1995 Annual Meeting*, Miami Beach, FL

[12] Bakshi, B. R.,"Environmentally Conscious Manufacturing - Challenges for Process Control", *Institute For Operations Research and Management Sciences (INFORMS) Fall 1996 National Meeting*, November 3 - 6, 1996, Atlanta, GA

[13] Bansal, P., and B. R. Bakshi,"Noise Characterization and On-line Rectification of Chemical Process Data Using a Time-Frequency Representation", *AIChE 1996 Annual Meeting*, Chicago, IL

[14] Bakshi, B. R., and U. Utojo,"Unification of OLS, PCR, PLS, NLPCR, NLPLS, BPN, and PPR, with Application to Process Performance Monitoring", *AIChE 1996 Annual Meeting*, Chicago, IL

[15] Bakshi, B. R., P. Bansal, and M. N. Nounou,"Multiscale Methods for Rectification of Random Errors without Fundamental Process Models", *PSE/ESCAPE-97*, Trondheim, Norway, May 25-29, 1997

[16] Bakshi, B. R., P. Goel, and X. Shen,"Multivariate Statistical Process Monitoring and Denoising by Multiscale Principal Component Analysis", *International Symposium on Wavelets and Statistics*, Duke University, Durham, NC, October 13-14, 1997

[17] Bakshi, B. R.,"Multiscale Empirical Modeling Methods for Process Monitoring", *AIChE 1997 Annual Meeting*, Los Angeles, CA

[18] Nounou, M. N., and B. R. Bakshi,"On-line Multiscale Rectification of Random and Gross Errors without Process Models", *AIChE 1997 Annual Meeting*, Los Angeles, CA

[19] Bakshi, B. R., and S. Top,"Multiscale Statistical Process Control Using Wavelets", *Fall Technical Meeting, American Statistical Association/American Society for Quality*, Corning, NY, October 1998

[20] Bakshi, B. R., and S. Top,"Multiscale Statistical Process Monitoring and Diagnosis of Univariate and Multivariate Processes", *AIChE 1998 Annual Meeting*, Miami Beach, FL

[21] Nounou, M. N., B. R. Bakshi,"Multiscale Linear Modeling with Application to Inferential Modeling and System Identification", *AIChE 1998 Annual Meeting*, Miami Beach, FL

[22] Bakshi, B. R., M. N. Nounou, P. Goel, and X. Shen,"Multiscale Data Reconciliation with Steady State Process Models", *AIChE 1998 Annual Meeting*, Miami Beach, FL

[23] Bakshi, B. R., R. Strauss, and H. Aradhye,"Process Monitoring by PCA, Dynamic PCA and Multiscale PCA - Theoretical Analysis and Disturbance Detection in Tennessee Eastman Process", *AIChE 1999 Annual Meeting*, Dallas, TX

[24] Ungarala, S., and B. R. Bakshi,"Multiscale Bayesian Data Rectification of Linear and Nonlinear Dynamic Systems", *AIChE 1999 Annual Meeting*, Dallas, TX

[25] Aradhye, H., B. R. Bakshi, and J. F. Davis,"MSART: An On-Line Multi-Scale Hierarchy of ART-2 State Estimators", *AIChE 1999 Annual Meeting*, Dallas, TX

[26] Bakshi, B. R., "A Systems Ecology Framework for Including the Contribution of Ecological Products and Services in Process Design", *AIChE 2000 Annual Meeting*, Los Angeles, CA

[27] Nounou, M. N., B. R. Bakshi, P. K. Goel, X. Shen, "Improving Principal Component Analysis by Bayesian and Multiscale Estimation", *AIChE 2000 Annual Meeting*, Los Angeles, CA

[28] Aradhye, H. B., B. R. Bakshi, R. A. Strauss, J. F. Davis, "Multiscale Statistical Process Control and Fault Diagnosis - Theoretical Analysis and Extensions", *AIChE 2000 Annual Meeting*, Los Angeles, CA

[29] Nounou, M. N., B. R. Bakshi, P. K. Goel, X. Shen, "A Bayesian Framework for Linear Process Modeling and Identification", *AIChE 2000 Annual Meeting*, Los Angeles, CA

[30] Aradhye, H. B., M. Barroeta, J. F. Davis, B. R. Bakshi, "Data Interpretation using Single and Multi Scale Clustering of Nonlinear and Noisy Data", *AIChE 2000 Annual Meeting*, Los Angeles, CA

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[172] M. Charles, V. Vattyam, B. R. Bakshi, "Developing an Optimization Framework to Achieve Campus Carbon Neutrality with Both Technological and Ecological Solutions", AIChE Annual Meeting, Nov 16-20, 2020, Virtual

[173] K. Lee, S. Khanal, B. R. Bakshi, "Climate-Resilient Process Design Using the Flexibility Analysis Approach", AIChE Annual Meeting, Nov 16-20, 2020, Virtual

[174] U. D. Shah, J. Paulson, B. R. Bakshi, "Towards Integration of Design and Operation of Techno-Ecological Synergistic Systems", AIChE Annual Meeting, Nov 16-20, 2020, Virtual

[175] K. Lee, S. Chun, J. Bielicki, B. R. Bakshi, "Exploring a Computational Framework for Spatially-Explicit Absolute Sustainability Assessment Based on a Multi-Regional Hybrid Approach", AIChE Annual Meeting, Nov 16-20, 2020, Virtual

[176] V. Thakker, B.R. Bakshi, "Designing Life-cycle networks for a Sustainable and Circular Economy", American Council for Life Cycle Assessment, virtual conference, September 21-24, 2021

[177] Y. Xue, B. R. Bakshi, "Quantifying Absolute Sustainability in LCA with Ecosystem Services and Planetary Boundaries: Comparison, Computation, and Case Study", American Council for Life Cycle Assessment, virtual conference, September 21-24, 2021

[178] S. Chun, K. Lee, J. Bielicki, B. R. Bakshi, "A Multi-scale Multi-regional model for LCA of Carbon Emissions from Corn Farming in the U.S. Midwest", American Council for Life Cycle Assessment, virtual conference, September 21-24, 2021

[179] Y. Xue, B. R. Bakshi, "Planetary Boundaries, Ecosystem Services, and Life Cycle Assessment – Novel Insight By a Case Study and Computational Framework", American Institute of Chemical Engineers Annual Meeting, November 7-11, 2021, Boston, MA

[180] M. Charles, B. R. Bakshi, "A Hierarchical Techno-Ecological Decision Procedure for Sustainable Design", American Institute of Chemical Engineers Annual Meeting, November 7-11, 2021, Boston, MA

[181] V. Thakker, F. Hafsa, K. Dooley, B. R. Bakshi, "Developing Innovation Roadmaps for Plastics Value-Chain Using Sustainable Circular Economy Framework", American Institute of Chemical Engineers Annual Meeting, November 7-11, 2021, Boston, MA

[182] M. Charles, B. R. Bakshi, "Spatially-Explicit Techno-Ecological Design for Sustainable Manufacturing and Minimized Air Pollution Health Impacts", American Institute of Chemical Engineers Annual Meeting, November 7-11, 2021, Boston, MA

[183] V. Thakker, B. R. Bakshi, "Systematic Approaches for Discovering Innovations to Enable a Sustainable Circular Economy", American Institute of Chemical Engineers Annual Meeting, November 7-11, 2021, Boston, MA

[184] U. Shah, J. Paulson, B. R. Bakshi, "Enabling Real-Time Synergies in Techno-Ecological Systems Using Adaptive Nonlinear Model Predictive Control", American Institute of Chemical Engineers Annual Meeting, November 7-11, 2021, Boston, MA

[185] A. Sen, G. Stephanopoulos, B. R. Bakshi, "Towards a Circular Chemical Industry: Mapping the Flow of Fossil Carbon through Chemical Manufacturing Processes", American Institute of Chemical Engineers Annual Meeting, November 7-11, 2021, Boston, MA

[186] Y. Aleissa, B. R. Bakshi, "Process Sustainability Metrics Based on the Safe and Just Operating Space for Humanity", American Institute of Chemical Engineers Annual Meeting, November 7-11, 2021, Boston, MA

[187] A. Randall, M. Jones, E. Irwin, B. Bakshi, Y. Xue, "Weak and Strong Sustainability Assessment at Regional Scale – A Contribution to Regional Integrated Assessment Modeling with an Application to the Great Lakes Region", Association of Environmental and Resource Economists, Summer Conference, Miami, June 1-3, 2022

[188] Y. Xue, B .R. Bakshi, Encouraging Nature-Positive Decisions: An Open-Source Tool to Include Ecosystem Services in LCA for Absolute Environmental Sustainability Assessment, American Council for Life Cycle Assessment, virtual conference, Nov 8-11, 2022

[189] V. Thakker, B. R. Bakshi, Guiding Eco-Innovations to Transition Towards a Net-Zero Emissions and Circular Economy, American Council for Life Cycle Assessment, virtual conference, Nov 8-11, 2022

[190] S. Kim, A. Beier, H. B. Schreyer, B. R. Bakshi, Comparative Life Cycle Analysis for Buger Patty Production Using Novel Cultivated Meat in the United States, American Council for Life Cycle Assessment, virtual conference, Nov 8-11, 2022

[191] Y. Aleissa, B. R. Bakshi, Process Simulation with Trees As Unit Operations for Improving Air Quality, Sequestering Carbon, and Reducing Cost, AIChE Annual Meeting, Phoenix, AZ, November 13-18, 2022

[192] Y. Xue, B. R. Bakshi, Encouraging 'Nature Positive' Decisions: Toward an Open-Source Tool for Ecosystem Services-Based Absolute Environmental Sustainability Assessment, AIChE Annual Meeting, Phoenix, AZ, November 13-18, 2022

[193] A. Sen, V. Thakker, G. Stephanopoulos, B. R. Bakshi, Transforming the Chemicals and Materials Industry Toward Net-Zero Greenhouse Gas Emissions: Approach and Preliminary Results, AIChE Annual Meeting, Phoenix, AZ, November 13-18, 2022

[194] V. Thakker, B. R. Bakshi, Screening and Ranking Eco-Innovations for Sustainable Circularity: Hotspot and Sensitivity-Based Optimization, AIChE Annual Meeting, Phoenix, AZ, November 13-18, 2022

[195] V. Thakker, B. R. Bakshi, Developing Roadmaps to Guide Industry Toward a Future with Net-Zero Emissions and a Circular Economy, AIChE Annual Meeting, Phoenix, AZ, November 13-18, 2022

[196] A. Sen, B. R. Bakshi, Modeling Direct and Indirect Carbon Flows in the Chemicals and Materials Industry to Enable a Net-Zero Emissions Future, AIChE Annual Meeting, Phoenix, AZ, November 13-18, 2022

[197] Y. Aleissa, B. R. Bakshi, Impact of the Food-Energy-Water Nexus on Meeting the Constraints of Planetary Boundaries and Social Justice, AIChE Annual Meeting, Phoenix, AZ, November 13-18, 2022

[198] X. Zhen, B. R. Bakshi, Planning of Electricity Unit Commitment in Synergy with Nature's Ability to Mitigate Carbon Dioxide and Criteria Air Pollutants, AIChE Annual Meeting, Orlando, FL, November 5-10, 2023

[199] A. Sen, V. Thakker, G. Stephanopoulos, B. R. Bakshi, A Novel Framework for Design of Net-Zero Chemical Systems: Analysis and Results, AIChE Annual Meeting, Orlando, FL, November 5-10, 2023

[200] A. Sen, V. Thakker, G. Stephanopoulos, B. R. Bakshi, Roadmapping to Net-Zero Chemicals and Plastics: Analysis and Results, AIChE Annual Meeting, Orlando, FL, November 5-10, 2023

[201] Y. Xue, B. R. Bakshi, Designing a Li-Ion Battery Supply Chain Under Uncertainty for Nature-Positive Decisions, AIChE Annual Meeting, Orlando, FL, November 5-10, 2023

[202] Y. Xue, B. R. Bakshi, Absolute Environmental Sustainability Assessment of Chemicals and Bridging Gaps to Becoming 'Nature Positive', AIChE Annual Meeting, Orlando, FL, November 5-10, 2023

[203] A. Sen, Y. Xue and B. R. Bakshi, Designing Chemical Value Chains for Net-Zero Emissions and Nature Positive Decisions, AIChE Annual Meeting, Orlando, FL, November 5-10, 2023

[204] M. Charles and B. R. Bakshi, Adding a Spatial Dimension to Nature Based Solutions in Carbon Neutrality Planning through the Optimization of Ecological Co-Benefits, AIChE Annual Meeting, Orlando, FL, November 5-10, 2023

[205] S. Ma, B. R. Bakshi, L.-C. Lin Theoretical Assessment of PET Pyrolysis Via Reactive Molecular Dynamic Simulation and Kinetic Modeling, AIChE Annual Meeting, Orlando, FL, November 5-10, 2023

[206] F. Nazemi, R. Mulyana, J¿ M. Castro, B. R. Bakshi, Cradle-to-Cradle Life Cycle Assessment of Multilayer Plastic Films Used in Sheet Molding Compound Process, AIChE Annual Meeting, Orlando, FL, November 5-10, 2023

[207] S. Kim, B. R. Bakshi, Early-Stage Screening of Reaction Pathways for Innovation Toward a Sustainable and Circular Chemical Industry, AIChE Annual Meeting, Orlando, FL, November 5-10, 2023

[208] F. Nazemi, B. D. Fath, B. R. Bakshi, Ecological Network Analysis and Information Theory to Evaluate the Performance of Circular Economy Designs, AIChE Annual Meeting, Orlando, FL, November 5-10, 2023

Outreach Activities and Media Coverage

[1] Software based on research is developed for most of our work. Some examples include,

(a) NLCR - Nonlinear Continuum Regression

(b) MSSPC - Multiscale Statistical Process Control

(c) BLVR - Bayesian Latent Variable Regression

(d) SMC - Sequential Monte Carlo Sampling

(e) Eco-LCA - Ecologically Based Life Cycle Assessment

(f) TES-LCA - Techno-ecological synergy in life cycle assessment

(g) NetZ-Films - Analysis and design toward sustainable circular barrier films

(h) NetZ-CMI - Guiding the transition to a net-zero chemicals and materials industry

[2] Data from the paper, "Nature-Based Solutions Can Compete with Technology for Mitigating Air Emissions Across the United States, *Environmental Science and Technology*, 2019" is included in the California Department of Conservation's Terracount tool (`https://maps.conservation.ca.gov/terracount/`). This is a scenario planning tool for cities, counties and other regions. This data is being used to determine the current air qualiity regulation ecosystem service provided by vegetation in Merced county.

[3] Media coverage for the paper, "Nature-Based Solutions Can Compete with Technology for Mitigating Air Emissions Across the United States, *Environmental Science and Technology*, 2019." Altmetric has tracked 13,757,382 research outputs across all sources so far. Compared to these this one has done particularly well and is in the 99th percentile: it's in the top 5% of all research outputs ever tracked by Altmetric. Covered on outlets such as, Science Daily, phys.org, inverse.com, Newswise, upi.com, ANI news, The Medical News, Breitbart, Long Room, Business Standard, Tree Hugger, AZO Cleantech, Outlook, Firstpost, The Asian Age, India Times, The Siasat Daily, Deccan Chronicle, Prokerala.com, India4U.com, News19, NewKerala, ZeeNews, OdishaTV, Sign of the Times, The Tribune, Hindustan Times, CNBC TV18, India TV. Interviewed on WCMH NBC TV station, Sirius XM program "Pulmonology," and West Virginia Public Radio.

[4] Data from the paper Gopalakrishnan, V., S. Hirabayashi, G. Ziv and B. R. Bakshi,"Air quality and human health impacts of grasslands and shrublands in the United States" Atmospheric Environment, 182, 193-199, 2018 is included in the i-Tree Eco software (`itreetools.org`) developed by the US Department of Agriculture Forest Service.

[5] This article, Adding power to the value of trees by L. Palmer in *Nature Energy*, 2, 17020, 2017, discussed the work in our paper, "Assessing the Capacity of Local Ecosystems to Meet Industrial Demand for Ecosystem Services," *AIChE Journal*, 2016

[6] Participant in "Portals to the Public" program of the Central Ohio Science and Industry (COSI) Museum. The program focuses on science communication and public engagement.

[7] Interviewed on BBC World Service's World Business Report program, "India Forges Ahead with Nuclear Power," May 7, 2013.

[8] Interviewed by ET Now, India, program on "Packaging and the Environment," December 2011

[9] Interviewed by India Today, Aspire magazine, "The Green Brigade," September 1, 2011

[10] Bakshi, B. R., "Nanotechnology, Solar Energy, Biofuels, Oh My! Can Technology Lead to Sustainability?" First Community Church, Men's Lunch Series, Upper Arlington, OH, May 26, 2008

[11] Bakshi, B. R., "Can Technology Lead to Sustainability", AIChE student chapter meeting, 2007

[12] Interviewed on Earth & Sky radio program's Human World project, (`www.earthsky.org/humanworld`)

Funded Research

[1] **Ohio State University**, "Combining Wavelets and Artificial Neural Networks for Process Operation and Control", Seed Grant, $20,000, 1994-95

[2] **American Cyanamid Company**, "Intelligent Operation of Fermentation Processes", $7,500, Sep - Dec 1994 (co-PI with Prof. James F. Davis),

[3] **Ohio State University**, International Travel grant, $1,000, 1994

[4] **Gordon Conference on Statistics in Chemistry and Chemical Engineering**, young researcher participation award, New Hampton, NH, July 30 - Aug 4, 1995

[5] **Ohio Aerospace Institute**, "Intelligent Process Monitoring and Information Extraction from Measured Data Using Neuro-Statistical Methods", Contract, $30,000, 1995-97

[6] **Electrical Power Research Institute**, "Applications of Nonlinear Dynamics to Utilities-Related Materials Problems", $307,397, Aug 1995 - Jun 1998, (co-PI with Prof. Alan J. Markworth, Materials Science)

[7] **American Chemical Society - Petroleum Research Fund**, "Novel and Integrated Techniques for Data Rectification, Compression and Multivariate Statistical Process Monitoring", Starter Grant, $20,000, 1996-98

[8] **Technical Association of Paper and Pulp Industries**, "Integrated Data Analysis and Information Extraction from Measured Data in Millwide Information Systems", Grant, $40,000, 1996-97

[9] **DuPont Educational Aid Program**, "Process Modeling and Operation Using Wavelets", Grant, $55,000, 1996-99

[10] **Air Force Office of Scientific Research**, Asia Office, Travel Grant for IPMM '97 meeting, $2,000, 1997

[11] **Air Force Office of Scientific Research**, Wright-Patterson Airforce Base, "Improving the Efficiency of Empirical Modeling by Nonlinear Continuum Regression", Grant for Exploratory Research, $15,000, February - April, 1998

[12] **National Science Foundation, Faculty Early Career Enhancement (CAREER) Award**, "Data Rectification, Process Monitoring, Fault Diagnosis, and their Integration Using Multiscale Empirical Modeling", $210,000, 1998 - 2002

[13] **National Science Foundation**, Matching funds for CAREER Award, "Data Rectification, Process Monitoring, Fault Diagnosis, and their Integration Using Multiscale Empirical Modeling", $100,000, 1999 - 2003

[14] **National Science Foundation / Environmental Protection Agency Program on Technology for a Sustainable Environment**, "A Systems Ecology Approach to Life-Cycle Product Assessment and Process Design", $267,382, 2000 - 2004

[15] **Ohio Technology Action Fund**, "Chemical Genomics Discovery Platform with Novel Informatics Methods to Link Genes to Drugs", $721,411.00, 2002 - 2004 (co-PI with Drs. C. Yang and P. Blower, LeadScope Inc., and Prof. James F. Rathman, Dept. of Chem. Eng.)

[16] **National Science Foundation**, "PREMISE: Ecologically and Economically Conscious Manufacturing of Polymer Composites - Coating Process Selection", $100,000, 2002-2003 (co-PIs are Profs. L. J. Lee, J. Castro, J. Kardos)

[17] **National Science Foundation**, "Bayesian Recitification of Nonlinear Dynamic Chemical Process Systems", $430,121, 2003-2006 (co-PI Prof. Prem Goel, Statistics)

[18] **National Science Foundation**, "MUSES: Multiscale Bayesian Approach for Life Cycle Assessment - The Case of Transportation Fuels", $120,000, 2004-2005 (co-PIs Profs. R. Fortner, Natural Resources; P. K. Goel, Statistics; T. Haab, AEDE)

[19] **Arkema, Inc.**, "Bayesian Methods for Advanced Data Mining and Information Extraction", $40,123, 2004-2005.

[20] **Environmental Protection Agency**, "Life Cycle Assessment of Ionic Liquids", $95,000, 2004-2008.

[21] **National Science Foundation**, "CANPBD: Evaluating the environmental impacts of nanomanufacturing via thermodynamic and life cycle analysis", subcontract from Nano Science and Engineering Center grant, $34,641 per year, 2005-2009

[22] **National Science Foundation**, "BE-MUSES: A Multiscale Statistical Framework for Assessing the Biocomplexity of Materials Use - The Case of Transportation Fuels", $1,567,500, 2005-2010 (co-PIs Profs. P. K. Goel, Statistics; T. Haab, Ag. Env. Dev. Econ.; M. Morrone, Env. Health, Ohio Univ.)

[23] **OSU Transportation Research Endowment Program (TREP)**, Matching funds for NSF grant, $175,000, 2005-2010

[24] **Environmental Protection Agency**, "Evaluating the Impacts of Nanomanufacturing via Thermodynamic and Life Cycle Analysis", $375,000, 2005-2008 (co-PI: Prof. L. James Lee).

[25] **National Science Foundation**, "BE-MUSES: A Multiscale Statistical Framework for Assessing the Biocomplexity of Materials Use - The Case of Transportation Fuels", Supplementary funds from Research Experience for Undergraduates program, $12,000, 2006-2007.

[26] **Environmental Protection Agency**, Collaborative Science and Technology Network for Sustainability, "Partnership for Industrial Ecology in Central Ohio", $300,000, 2006-2009 (PI: Dr. Joseph Fiksel)

[27] **Caterpillar Inc.**, "Life cycle management applied to welding technologies at Caterpillar", $199,000, 2007-2008 (PI: Dr. Joseph Fiksel)

[28] **Environmental Protection Agency**, "Life Cycle Assessment of the Production and Use of Ethanol from Cellulose", $99,866, 2007-2008

[29] **Holcim Inc (US)**, "Life Cycle Assessment of Alternative Uses of Waste Tires", $120,000 , 2008-2009

[30] **American Beverage Association**, "LCA of Beverage Containers", $40,000, Apr - Dec 2008

[31] **National Science Foundation**, "Toward Integration of Industrial Ecology and Ecological Engineering", $300,000, 2008-2011, (co-PI: William Mitsch)

[32] **OSU Institute for Energy and the Environment**, "Enabling Energy System Transitions via Integrated Modeling of Resilience and Sustainability", $45,000, 2008-2009, (co-PIs: J. Doyle (Caltech), J. Fiksel, J. Guldmann, F. Hitzhusen, A. Murray, D. Woods)

[33] **OSU Institute for Energy and the Environment**, "Carbon Footprint Reduction and Graduate Interdisciplinary Specialization in Sustainability at OSU", $15,000, 2008-2009, (co-PIs: J. Fiksel, P. Goel, T. Haab, R. Lal, W. Mitsch)

[34] **Environmental Protection Agency**, "Comparative Study of Thermodynamics Based Life Cycle Assessment of Nano-Materials with Conventional Technologies", $100,000, 2008-2010

[35] **OSU Center for Energy, Sustainability and the Environment**, "Toward Renewable Electricity, Carbon Sequestration and Clean Water via Integrated Design of Industrial and Ecological Systems", $7,500, 2008-2009, (co-PIs: J. J. Chalmers, W. J. Mitsch)

[36] **U.S. Department of Agriculture**, "Development and demonstration of a low VOC polyurethane coating system using biopolyois derived from crude glycerol", $418,965, 2012-2014, (PI; Yebo Li, co-PI: Rudy Bucheit)

[37] **U.S. Department of Agriculture**, BRDI program, "Bioenergy and Biofuels Production from Lignocellulosic Biomass via Anaerobic Digestion and Fisher-Tropsch Reaction", $6,000,000, 2013-2017, (PI; Yebo Li)

[38] **OSU Insitute for Energy and the Environment**, "Toward Eminence in Sustainability: The OSU Campus as a Living Laboratory for Ecological Footprint Reduction", $65,632, 2012-2013, (co-PIs: J. Fiksel, J. Martin, R. Lal, et al.)

[39] **National Science Foundation**, "Seeking Synergy Between Technological and Ecological Systems for Sustainable Engineering", $300,000, 2013-2016, (co-PI: Michael Lepech, Stanford Univ.)

[40] **National Science Foundation**, "US-UK Planning Visit: Techno-Ecological Synergy for Sustainable Engineering", $46,645, 2014-2015

[41] **National Science Foundation**, "SRN: Integrated Urban Infrastructure Solutions for Environmentally Sustainable, Healthy and Livable Cities", $410,000 out of $12 million, 2015-2021 (PI: Anu Ramaswami, U. Minnesota)

[42] **National Science Foundation**, "SRN: Urban Resilience to Extremes", $99,994 out of $14 million, 2015-2020 (PI: Charles Redman, Arizona State Univ.)

[43] **Ford Motor Company**, "Life Cycle Assessment of Carbon Fiber Composites for Auto Applications", $179,085, 2016-2018

[44] **Ohio Water Resources Center**, "Addressing the Water-Energy Nexus of Fossil Power Generation by Considering Technological, Agro-Ecological, and Economic Options in the Muskingum Watershed", $35,000, 2017-2018 (co-PIs: Brent Sohngen and Sami Khanal)

[45] **OSU Office of Energy and Environment**, "OSU Climate Action Plan", $71,153, 2017-2018

[46] **Sustainable and Resilience Economy program** at OSU, "Coupling technological, economic, and ecological systems: Integrating ecosystem services in the design of a biodiesel facility in Cincinnati, Ohio", seed grant, $47,881, 2017-2018 (PI: Antonio Conejo, co-PI: Daniela Miteva)

[47] **Sustainable and Resilience Economy program** at OSU, "FEW prints of household consumption", seed grant, $45,000, 2017-2018 (PI: Nicole Sintov)

[48] **National Science Foundation**, INFEWS/T1: Impacts of deglobalization on the sustainability of regional food, energy, water systems, $2,400,000 2018-2021 (PI: Elena Irwin)

[49] **National Science Foundation**, Including ecosystems in process design and life cycle assessment for environmental sustainability and innovation, $360,000, 2018-2021

[50] **Global Kaiteki Center** at Arizona State University, Circular Economy of Plastics, $75,000, 2019-2021

[51] **National Science Foundation**, NSF 2026: Convergence around a sustainable world without waste, $100,000, 2020-2021 (with co-PIs Bilec, Irwin, Isenhour, Gutowski, Sekulic, Theis, Thomas)

[52] **National Science Foundation**, NSF 2026:EAGER: Spatio-Temporal Design of Techno-Ecological Synergies for a World without Waste and Resilient Landscapes, $299,954, 2021-22 (with co-PIs Paulson and Bohrer)

[53] **National Science Foundation**, EFRI E3P: Sustainable and Circular Engineering for the Elimination of End-of-life Plastics: A Framework for Assessment, Design, and Innovation, $2,000,000, 2020-24 (with co-PIs Lin, Sintov (OSU), Allen (UT Austin), Savage, Pester (PSU))

[54] **Fairlife Co.**, Fairlife Life Cycle Assessment, $288,943, 2021-2022 (with co-PI's Jimenez-Flores, Chiavetago (OSU))

[55] **SERB-VAJRA, Department of Science and Technology, India**, Optimal and sustainable of operation of thermal power generation systems: A study in the context of Indian scenario, $30,000, 2021-22 (with co-PIs Hariprasad Kodamana and Manoj Ramteke of IIT Delhi)

[56] **REMADE Institute** Department of Energy, Analysis and Design for Sustainable Circularity of Barrier Film in Sheet Molding Composites, $902,585, 2022-2024 (with co-PIs Castro (OSU), Dooley (ASU), Stephanopoulos (ASU), Hanes (NREL), Montazeri (Kohler Co.))

[57] **Erasmus+ project, European Union** Hungarian University of Agriculture and Life Sciences, Methodology development for combined application of upper level evaluations with lower level mechanistic models for bio-based circular economy, Gödöllő, Hungary, 2022-23

[58] **SPARC, Ministry of Education, Government of India**, Integrated global and regional assessment of food, energy, and water sustainability, $15,000, 2020-2022, (led by Yogendra Shastri, Indian Institute of Technology Mumbai, India, with G. Haripriya (IIT), Urmila Diwekar (Univ. of Illinois, Chicago))

Consulting Activities

ExxonMobil Research, Virtual Scale-Up, 2001

LeadScope Inc., Bioinformatics, 2002

Owens-Corning, Inc., Assessment of the greenness of building materials, 2008

Biomimicry Guild, Design of Sustainable Cities, 2010

Eaton Corporation, Streamlined LCA, 2012

Chembond India, Ecological Engineering, 2012-13

Battelle, Carbon footprint, 2016

AspenTech, Sustainable Engineering, 2021

Jabil Inc., Design for Sustainability, 2021

Visitors, Post-Doctoral Researchers, and Graduate Students

Visitors

Dr. Diogo Silva, Federal University of Sao Carlos, Brazil (Spring 2023), Mr. Fabio Sporchia, University of Siena, Italy, (Nov '22 - May '23), Dr. Monika Varga, Fulbright scholar, Kaposvar University, Hungary (Fall 2019), Dr. Bela Csukas, Kaposvar University, Hungary (Fall 2019), Mr. Fabrizio Saladini, University of Siena, Italy (2016), Ms. Hyoseon Kim, POSCO, Korea (2012-13); Dr. Luis Antonio Quintero, EAFIT University, Medellin, Colombia (May-July 2011); Dr. Roberto Ridolfi, University of Siena, Italy (June-July 2006); Prof. Jingqin Su, Dalian University of Technology (2002-2003); Mr. Marco P. Seabra dos Reis, Coimbra University, Portugal (Jun. - Aug. 2001); Dr. Manabu Kano, Kyoto University, Japan (1999-2000); Mr. Noel Cabigon, De LaSalle University, Philippines, (1997-98)

Post-doctoral researchers

Nandita Saraf (Mar '24 -), Avan Kumar (Dec '23 -), Reena Sharma (Nov '23 -), Robert A. Urban (Jan '13 - June '13); Geoffrey Grubb (Jun '11 - May '12); Anil Baral (Jun '06 - Jun '09); Jun-Ki Choi (Jan '07 - May '09); Heui-Seok Yi (Nov '03 - Nov '06); Wen-shiang Chen (May-December 2004); Sridhar Ungarala (Jan. - Dec. 1999)

Doctoral students

Current: Jaafar Ballout, Kevin Donnelley (co-advised with Prof. Joel Paulson), Sunghoon Kim, Shuangxiu Ma (co-advised with Prof. Li-Chiang Lin), Aniket Mali, Farshid Nazemi, Om Sambhe, Xinyu Zhen
Former: Ying Xue, 2024, Amrita Sen, 2024, Soomin Chun (co-advised with Profs. Jeff Bielicki and Jay Martin), 2023; Vyom Thakker, 2023; Yazeed Aleissa, 2022; Utkarsh Shah, 2022; Michael Charles, 2021; Kyuha Lee, 2020; Tapajyoti Ghosh, 2019; Xinyu Liu, 2018; Shelly Bogra (co-advised with Dr. Ritu Mathur, TERI University, New Delhi), 2017; Varsha Gopalakrishnan, 2017; Rebecca Hanes, 2015; Sachin Jadhao, 2015 (co-advised with Prof. A. B. Pandit, ICT Mumbai); Prasad Mandade, 2015 (co-advised with Prof. G. D. Yadav, ICT Mumbai); Erin Gibbemeyer, 2014; Laura Merugula, 2013; Berrin Kursun, 2013; Nathan Cruze, 2012 (co-advised with Prof. P. K. Goel); Robert A. Urban, 2012; Shweta Singh, 2012; Geoffrey Grubb, 2010; Vikas Khanna, 2009; Yi Zhang, 2008; Lixin Lang, 2008 (co-advised with Prof. P. K. Goel); Hongshu Chen, 2007 (co-advised with Prof. P. K. Goel); Jorge Hau, 2005; Nandan Ukidwe, 2005; Wen-Shiang Chen, 2004; Hrishikesh B. Aradhye, 2001 (co-advised with Prof. J. F. Davis); Mohamed Nounou, 2000

Masters students

Current: Malaika Malik
Former: Vivek Vattyam, 2021; Amrita Sen, 2021; Kevin Do, 2020; Jingying Hu, 2019; Shubhankar Upasani, 2019; Ruonan Zhao, 2019; Xiangming Gu, 2018; Muzhapaer Motianlifu, 2017; Stefan Heglas, 2016; Emily Helber, 2016; Don Irby, 2016; Xiang Zhang, 2015; Balaji Ethiraj (co-advised with Prof. A. V. Patwardhan, ICT Mumbai), 2011; Amit Jangle (co-advised with Prof. A. B. Pandit, ICT Mumbai), 2011; John Davenport, 2010 (co-advised with Prof. P. K. Goel); Hrishikesh Yadav (ICT Mumbai), 2010; Karan Chavan (ICT Mumbai), 2009; Prasad Mandade (ICT Mumbai), 2009; Daniel Arthur, 2005; Srinivasan Ganesan, 2002; Oscar Lara, 2000 (co-advised with Prof. J. J. Chalmers); Ramon Strauss, 2000; Sermin Top, 1999; Raja Chatterjee, 1998; Mohamed Nounou, 1997; Prakhar Bansal, 1996; Huan Zhong, 1996 (co-advised with Prof. L.-S. Fan); Utomo Utojo, 1996;

Courses Taught

University Courses

Chemical Process Dynamics and Control, Chemical Engineering 624, Fall 1996, Fall 1998, Fall 1999, Fall 2000, Fall 2001, Fall 2002, Fall 2003, Fall 2004, Fall 2005, Fall 2007, Fall 2008, Spring 2013, Fall 2013, Spring 2016, Fall 2016, Spring 2018, Spring 2019, Fall 2020

Digital Control Techniques in Chemical Engineering, Chemical Engineering 626, Winter, 1994, Winter 1996, Winter 1997, Spring 1998, Spring 1999, Spring 2000, Spring 2001

Chemical Engineering Process Design, Chemical Engineering 764, Spring 1994, Winter 1995, Spring 1996, Spring 1997, Winter 2001, Winter 2002, Winter 2003, Winter 2004, Winter 2005, Winter 2006, Winter 2007, Winter 2008, Winter 2009, Spring 2010, Spring 2011, Spring 2012

Statistical Methods in Chemical Engineering, Chemical Engineering 779, Summer 1999

Principles of Sustainable Engineering, Chemical Engineering 694E, Spring 2002, Spring 2003, Spring 2004, Spring 2005, Spring 2006, Spring 2007, Spring 2008, Spring 2009, Spring 2010,

Spring 2011, Spring 2012, Spring 2013, Spring 2014, Spring 2015; Spring 2016; Spring 2017, Spring 2018, Spring 2019; Spring 2020; Fall 2021; also taught at ICT, Mumbai in 2008 and 2009; short version at IIT Delhi in Fall 2021

Chemical Engineering Process Calculations, Chemical Engineering 200, Fall 1994, Fall 1997

Seminar in Chemical Engineering, Chemical Engineering 881, Summer, 1994, Summer 1995, Summer 1996

Seminar Course on Wavelets for Engineering Applications, Electrical Engineering 881, Fall 1994

Process Systems Engineering, Institute of Chemical Technology, Mumbai, Fall 2011

Process Control, Institute of Chemical Technology, Mumbai, Spring 2011

Separation Processes, Institute of Chemical Technology, Mumbai, Spring 2011

Short Courses and Professional Education

Absolute Sustainability, Planetary Boundaries, Ecosystem Services, and LCA: Theory and Application, American Council for Life Cycle Assessment, virtual, November 7, 2022

Eco-Mimicry for Sustainable Engineering, Hungarian University of Agriculture and Life Sciences, Szent István campus, Gödöllő, Hungary, April 27, 2022

Eco-Mimicry for Sustainable Engineering, Faculty Development Program on "Outcome Based Teaching-Learning", Pravara Rural Engineering College, Loni, India, March 24, 2022

Design for Sustainability and Circularity of Products and Processes, pre-conference workshop at the annual meeting of the American Council for Life Cycle Assessment, September 21, 2020, and September 20, 2021, on-line

Sustainable Engineering, Indian Institute of Technology, Mumbai, India, July, 2014; Aug 2016; December 2017-2019

Ecosystem Services in Life Cycle Assessment, pre-conference workshop at the annual meeting of the American Council for Life Cycle Assessment, September 24, 2018, Fort Collins, CO

Energy, Sustainability and Life Cycle Assessment, MIT Professional Education, 2.50s, Cambridge, MA, June 2011-17, with T. G. Gutowski and D. P. Sekulic

Life Cycle Assessment, Trottier Institute for Sustainable Engineering and Design, McGill University, Canada, May 9, 2016

Sustainable Engineering - Advances and Opportunities, South China University of Technology, Guangzhou, China, August 19-25, 2014

Strategic Business Decision Making for Sustainability, TERI Executive Education Program, Gurgaon, India, March 15-16, 2011, with Joseph Fiksel

Ecosystem Services and Sustainable Engineering, U.S. Environmental Protection Agency, short course as a part of the Ecosystem Services Seminar Series, National Risk Management Research Laboratory, Cicinnati, Ohio, November 19, 2009

Sustainability in Business Decision Making, Fisher College of Business, Executive Education, May 5 and November 16, 2009, with Joseph Fiksel

Resilient Today - Sustainable Tomorrow, Fisher College of Business, Breakfast Club - Executive Education, March 20, 2009, with Joseph Fiksel

Short Course on "Exergy Analysis", taught at Babcock and Wilcox, June, 2006

Short Course on "Thermodynamic Methods for Sustainability", taught at U.S. Environmental Protection Agency, National Risk Management Research Laboratory, Cincinnati, Ohio, Summer 2002

Membership in Professional Societies

American Institute of Chemical Engineers

International Society for Industrial Ecology

American Center for Life Cycle Assessment

American Association for the Advancement of Science

Professional Service Activities

Chair, 2021-22, Area 10A, Process Design, Computing and Systems Technology division, AIChE

Chair, 2009-2011, Area 23A, General, Sustainable Engineering Forum, AIChE

Director, 2008-2010, Computing and Systems Technology (CAST) Division, AIChE

Conference Organizing Committees

Member of several conference organizing committees in areas related to sustainable engineering and process systems engineering. Some examples are listed below.

Foundations of Computer-Aided Process Design, Member of Programming Committee 2023

International Society for Industrial Ecology, Biannual Meeting, Member of Programming Committee, 2023

NSF workshop on *Convergence Around a Sustainable World Without Waste*, chair, 2021

Enterprise and Infrastructure Resilience Workshop, co-chair, 2020

International Congress on Sustainability Science and Engineering, ICOSSE, Member of Programming Committee, 2014-2020

IEEE International Symposium on Sustainable Systems and Technlogy, IEEE-ISSST, Member of Programming Committee, Washington, DC, May, 2010

Foundations of Computer Aided Process Design, Member of Programming Committee, Breckenridge, Colorado, July 2009

IEEE International Symposium on Sustainable Systems and Technlogy, IEEE-ISSST, Member of Programming Committee, Phoenix, Arizona, May, 2009

International Symposium on Advanced Control of Industrial Processes, Member of International Programming Committee, Seoul, Korea, August 2005

Second International Exergy, Energy and Environment Symposium, Member of programming committee, Kos, Greece, July 2005

International Green Energy Conference (IGEC-1), Member of International Scientific and Advisory Committee, Waterloo, Ontario, Canada, June 2005

2nd International Conference on Green and Sustainable Chemistry and 9th Annual Green Chemistry and Engineering Conference, Member of technical committee, Washington, DC, June 2005

Member, International Program Committee, International Federation of Automatic Control, Dynamics of Chemical Processes (DYCOPS) conference, Boston, July 5-7, 2004

2nd Meeting of International Society for Industrial Ecology, Member, Technical Advisory Committee, 2003, Ann Arbor, MI

Conference Session Organization

Organizer and co-chair of numerous sessions at various meetings such as those listed below.

Session organizer and co-chair, Life Cycle Assessment, IEEE Symposium on Electronics and the Environment, San Francisco, CA, May 2006

Session organizer and co-chair, Entropy and Materials, 2nd International Conference on Green and Sustainable Chemistry and 9th Annual Green Chemistry and Engineering Conference, Washington, DC, June 2005

Session organizer and co-chair, Life Cycle Assessment and Sustainable Design, 2nd International Conference on Green and Sustainable Chemistry and 9th Annual Green Chemistry and Engineering Conference, Washington, DC, June 2005

Session Chair, Economic Aspects of Achieving Sustainability, AIChE 2003 Annual Meeting, San Francisco, CA

Session Chair, Environmental Performance Monitoring and Metrics, AIChE 2003 Annual Meeting, San Francisco, CA

Session Chair, Measurement Validation and Fault Detection, AIChE 2002 Annual Meeting, Indianapolis, IN

Chair, Topical Conference on "Global Climate Change and the Chemical Industry", AIChE 2002 Spring Meeting, New Orleans, LA

Session Chair, Thermodynamics and Industrial Ecology, Inaugural meeting of the International Society for Industrial Ecology, Leiden, Netherlands, November 2001

Session Chair, Process and Controller Performance Monitoring, AIChE 2001 Annual Meeting, Reno, NV

Member, International Programming Committee, and Session Chair, 4th IFAC Workshop On On-Line Fault Detection & Supervision In The Chemical Process Industries, June 8-9, 2001, Seoul, Korea

Session Chair, Process and Controller Performance Monitoring, AIChE 1999 Annual Meeting, Miami Beach, FL

Session Chair, Process and Controller Performance Monitoring, AIChE 1998 Annual Meeting, Miami Beach, FL

Session Chair, Computer Integrated Manufacturing in the Chemical Process Industries, AIChE 1998 Annual Meeting, Miami Beach, FL

Session Chair, Computer Integrated Manufacturing in the Chemical Process Industries, AIChE 1997 Annual Meeting, Los Angeles, CA

Session Chair, Optimization II - Computer Integrated Manufacturing in the Chemical Process Industries, AIChE 1996 Annual Meeting, Chicago, IL

Organizing committee member and session chair, Adaptive Distributed Parallel Computing Symposium, Dayton, Ohio, August 8-9, 1996

Moderator, New Developments in Principal Component Analysis, Gordon Conference on Statistics in Chemistry and Chemical Engineering, New Hampton, NH, July 30 - Aug 4, 1995

Discussor, Monitoring, Diagnosis and Control, Intelligent Systems in Process Engineering, ISPE '95, Snowmass, CO, July 1995

Session co-chair, Automated Supervision of Processes, AIChE 1995 Spring National Meeting, Houston, TX, March 1995

Peer Review Activities

Journal Reviewer. AIChE Journal, Computers and Chemical Engineering, Industrial and Engineering Research, Automatica, Chemometrics and Intelligent Laboratory Systems, Journal of Chemometrics, Environmental Science and Technology, Journal of Industrial Ecology, Ecological Indicators, Ecological Modelling, Ecological Economics, International Journal of Life Cycle Assessment, Proceedings of the National Academy of Science, Science.

American Chemical Society - Petroleum Research Fund, Reviewer, Regular and Startup Grant programs, 1996-present

National Science Foundation, Regular reviewer for various divisions and programs over the last 30 years.

Department of Energy, SBIR Program, Proposal Reviewer, Phase I (in 1995) and Phase II (in 1996)

National Science Foundation of Austria, Reviewer

National Science and Engineering Research Council, Canada, Reviewer

Dept. of Chemical Engineering, MacMaster University, Hamilton, Ontario, Canada, External Examiner, February, 1997

Dept. of Chemical Engineering, University of Alberta, Canada, External Examiner, 2001

Dept. of Chemical Engineering, Indian Institute of Technology, Bombay, India, External Examiner, 2003

University

Promotion and tenure committee, School of Sustainability, 2023-present

Member of Faculty Advisory Board, OSU Sustainability Institute, 2018-2022

Member of President and Provost's Council on Sustainability, 2017-2022

Chair of Faculty Search Committee, Department of Chemical and Biomolecular Engineering, 2017-2018

Member of Faculty Advisory Committee, OSU India Gateway Office, 2012-present

Faculty Advisor, Engineers for a Sustainable World, OSU chapter, 2012-present

Co-Advisor, AIChE Student Chapter, 2005-2009

Member, Faculty Search Committee, 1995, 1996, 1997, 2004, 2015

Member, Graduate Studies Committee, 1995-97, 1999-03

Member, Department Computing Committee, 1994-present

Chair, Departmental Web design committee, 1999

Member, Departmental MS policy committee, 1998

Member, Department Safety Committee, 1997

Member, Ad Hoc Committee on College Computer Facilities Management, College of Engineering, 1996-97

Member, Departmental Special Events Committee, 1994-95

Member, Departmental Senior Design Sequence Review Committee, Spring 1994

Co-organizer, Department Career Day, Spring and Fall 1994

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