

Karen E. Willcox, MNZM, PhD
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Karen E. Willcox is Director of the Oden Institute for Computational Engineering and Sciences, Associate Vice President for Research, and Professor of Aerospace Engineering and Engineering Mechanics at The University of Texas at Austin. She is also External Professor at the Santa Fe Institute. She holds the W. A. “Tex” Moncrief, Jr. Chair in Simulation-Based Engineering and Sciences and the Peter O'Donnell, Jr. Centennial Chair in Computing Systems. Before joining the Oden Institute in 2018, she spent 17 years as a professor at the Massachusetts Institute of Technology, where she served as the founding Co-Director of the MIT Center for Computational Engineering and Associate Head of the MIT Department of Aeronautics and Astronautics. Prior to joining the MIT faculty, she worked at Boeing Phantom Works with the Blended-Wing-Body aircraft design group. Willcox has co-authored more than 120 papers in peer-reviewed journals and advised more than 60 graduate students. She is the recipient of multiple best paper awards and several awards for leadership and teaching. In 2017 she was appointed Member of the New Zealand Order of Merit (MNZM). She is a Fellow of the Society for Industrial and Applied Mathematics (SIAM) and a Fellow of the American Institute of Aeronautics and Astronautics (AIAA).

Education

1994 University of Auckland, Bachelor of Engineering, First Class Honours (Engineering Science)
1996 Massachusetts Institute of Technology, Master of Science (Aeronautics and Astronautics)
 Thesis: *Aeroelastic Computations in the Time Domain using Unstructured Meshes*
2000 Massachusetts Institute of Technology, PhD (Aeronautics and Astronautics)
 Thesis: *Reduced-Order Aerodynamic Models for Aeroelastic Control of Turbomachines*

Experience

University of Texas at Austin

2020-present Associate Vice President for Research
2018-present Director, Oden Institute for Computational Engineering and Sciences
2018-present Professor of Aerospace Engineering and Engineering Mechanics

Santa Fe Institute

2019-present External Professor

Massachusetts Institute of Technology

2001-2018 Assistant/Associate/Full Professor, Aeronautics and Astronautics
2011-2013 Associate Department Head, Aeronautics and Astronautics
2008-2018 Founding Co-Director, MIT Center for Computational Engineering

Singapore University of Technology and Design

2018 Visiting Professor (7-month stay)
2015 Visiting Professor (6-month stay)
2011 Visiting Associate Professor (6-month stay)

University of Auckland, New Zealand

2015 Visiting Professor, Department of Engineering Science (8-month stay)
2008-2009 Visiting Associate Professor, Department of Engineering Science (15-month stay)

Sandia National Laboratories

2005 Visiting Researcher, Computer Science Research Institute (5-month stay)

Stanford University

2005 Visiting Scholar (1-month stay)

Boeing Phantom Works

2000-2001 Visiting Researcher, Blended-Wing-Body Aircraft Design Group (1-year stay)

NASA Dryden Flight Research Center

1996 Aerospace Intern, Aerodynamics Branch

Professional Interests

Research: Data to decisions in engineering systems. Computational models and methods for design, optimization, control and uncertainty quantification of engineering systems. Predictive data science and scientific machine learning. Reduced-order modeling and multi-fidelity methods. Future aircraft technologies, aircraft system optimization, aircraft environmental impact, multidisciplinary design, unmanned aerial vehicles, Digital Twin, Digital Thread.

Education: EdTech for data visualization, modeling and analytics (mapping.mit.edu). Fly-by-Wire intervention to enable scalable differentiated instruction in community colleges (fbw.mit.edu). Mapping learning outcomes across the undergraduate engineering curriculum (xoces.mit.edu); linking topics across the curriculum (crosslinks.mit.edu).

Teaching: Principles of Automatic Control (undergraduate), Computational Methods in Aerospace Engineering (undergraduate), Signals and Systems (undergraduate), Multidisciplinary System Design Optimization (graduate), Flight Vehicle Aerodynamics (graduate), Numerical Methods for Partial Differential Equations (graduate).

Diversity, Equity and Inclusion: Established new Diversity, Equity, Inclusion and Outreach Committee at the Oden Institute. Grew diversity of undergraduate and graduate aerospace engineering student body as Associate Department Head in MIT. Led Rising Stars events at MIT and UT Austin to foster gender diversity in aerospace engineering and computational sciences. Active in outreach activities to promote girls' interest in science, mathematics and engineering, including volunteer grade school science extension classes, many outreach visits to K-12 schools, and participation in the Advisory Board for Girls' Angle. First-generation student mentor at MIT.

Professional Memberships

Fellow, American Institute of Aeronautics and Astronautics (AIAA)

Fellow, Society for Industrial and Applied Mathematics (SIAM)

Member, American Society for Engineering Education (ASEE)

Member, American Mathematical Society (AMS)

Member, Design Society

External Boards and Committees (current)

Advanced Simulation and Computing (ASC) Advisory Board at the Los Alamos National Laboratory (2021 – present)

MATH+ Scientific Advisory Board, Germany (2021 – present)

SIAM Activity Group on Data Science (Inaugural Program Director, 2021 – 2022)

Co-Chair, SIAM 2022 Conference on Mathematics of Data Science

AIAA 2022 SciTech Forum Executive Steering Committee (2021 – 2022)

AIAA Board of Trustees (2020 – 2023)

Institute for Mathematical and Statistical Innovation (IMSI) Board of Trustees (2020 – 2024)

Advisory Board, Center of Excellence on Sustainable and Energy Efficient Aviation, TU Braunschweig, Germany (2020 – present)

NSF Advisory Committee for Cyberinfrastructure (2019 – present, Co-chair 2020 – 2022)

Science Board, Santa Fe Institute (2019 – present)

SIAM Journals Committee (2019 – present)

External Advisory Board, Michigan Institute for Computational Discovery and Engineering, University of Michigan (Member, 2017 – present)

National Academies Board on Mathematical Sciences and Analytics (BMSA) (2016 – present)

Advisory Board, Girls' Angle (2014 – present)

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External Boards and Committees (past)

National Academies Planning Committee on the Workshop on the Frontiers of Mechanistic Data-Driven Modeling for Additive Manufacturing (2019)

AIAA Fellows Selection Committee (2019 – 2021)

SIAM Fellows Selection Committee (2018 – 2020)

Department of Energy Working Group on Basic Research Needs for Scientific Machine Learning (2017 – 2019)

National Academies Committee to Assess the Risks of Unmanned Aircraft Systems (UAS) Integration (2017 – 2018)

SIAM Committee on Science Policy (2016 – 2018)

SIAM Activity Group on Computational Science and Engineering: Vice President (2013 – 2015), Program Director (2011 – 2013)

Co-Chair, SIAM 2013 Conference on Computational Science and Engineering

Co-Chair, Institute-wide Task Force on the Future of MIT Education (2013 – 2014)

MIT OpenCourseWare Faculty Advisory Committee (2011 – 2018; Chair 2015 – 2018)

Advisory Board, Department of Engineering Science, University of Auckland (Member, 2008 – 2018)

National Research Council, Committee to Conduct an Independent Assessment of the Nation's Wake Turbulence Research and Development Program (2007)

National Academies Decadal Survey of Civil Aeronautics, Aerodynamics and Acoustics Panel (2005 – 2006)

AIAA MDO Conference Technical Chair (2011 – 2012)

AIAA Multidisciplinary Design Optimization Technical Committee (2001 – 2021); Chair (2019 – 2021); Vice-Chair (2017 – 2019); Awards Subcommittee Chair (2003 – 2006); Publications Subcommittee Chair (2011 – 2018)

Visiting Committees and Review Boards

ExxonMobil Corporate Strategic Research, Capability Assessment External Review Panel (Physics and Mathematical Science and Scientific Computing) (2021)

Review Committee, Research Assessment of Aerospace Engineering, Delft University of Technology, Netherlands (2020 – 2021)

Committee to Visit Harvard University Information Technology (Member, 2019)

National Academies Panel on Review of the Information Technology Laboratory (ITL) at the National Institute of Standards and Technology (NIST) (2018)

Review Committee, TU Braunschweig Universities of Excellence, German Excellence Initiative (2018)

External Review Board, Computing and Information Sciences Research Foundation, Sandia National Laboratories (Member, 2016 – present)

Visiting Committee, Applied Mathematics & Statistics Department, Colorado School of Mines (Member, 2017)

HarvardX Review Committee, Harvard University (Member, 2016)

Board of Visitors, Institute for Computational Engineering and Sciences, University of Texas at Austin (2012 – 2018; Chair 2015 – 2018)

Assessment Committee, Accreditation of Aerospace Engineering, Delft University of Technology, Netherlands (2013)

Committee of Visitors, Division of Mathematical Sciences, National Science Foundation (Member, 2010)

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Editorial Boards

Acta Numerica (Editorial Board Member, 2021 – present)

IEEE Computing in Science and Engineering (CiSE) (Associate Editor, 2021 – present)

AIAA Journal (Editorial Board Member, 2021 – present; Associate Editor, 2015 – 2020 and 2009 – 2011)

Journal on Data Centric Engineering (Advisory Board, 2019 – present)

SIAM Journal on Scientific Computing (Section Editor, 2013 – 2019; Associate Editor, 2008 – 2013)

ASA/SIAM Journal on Uncertainty Quantification (Associate Editor, 2012 – 2013)

SIAM Book Series on Computational Science and Engineering (Editorial Board Member, 2009 – present)

Leadership Activities

Academic: Given hundreds of invited lectures in the US and internationally, including multiple plenary/keynote talks at major international conferences. In 2021 delivered plenary talks at AIAA Scitech Forum (largest aerospace engineering conference) and SIAM Conference on Computational Science and Engineering (largest computational science and engineering conference). Published over 120 papers in refereed archival journals. Supervised theses for 60 graduate students (40 M.S., 20 PhD). Multiple graduate students and postdocs hold academic positions at prestigious universities and leadership positions in industry. Secured funding and managed multi-institutional research projects from many sources including the U.S. Air Force, Boeing, U.S. Department of Energy, Federal Aviation Administration, NASA, National Science Foundation, DARPA, and U.S. Department of Education.

Major multi-institution research grants as lead include: Co-lead PI and Co-Director, AEOLUS Multifaceted Mathematics Capability Center on Advances in Experimental Design, Optimal Control, and Learning for Uncertain Complex Systems (Department of Energy, \$10M total budget over 4 years). Lead PI, Multidisciplinary University Research Initiative (MURI) project on Managing Multiple Information Sources of Multi-physics Systems (Air Force Office of Scientific Research, \$7.2M total budget over 5 years). Lead PI, MURI project on Machine Learning for Physics-Based Systems (Air Force Office of Scientific Research, \$2M total budget over 3 years). Lead PI, RISE of the Machines: Robust, Interpretable, Scalable, Efficient Decision Support (Department of Energy, \$4.4M total budget over 3 years). Co-lead PI and Co-Director, DiaMonD Multifaceted Mathematics Capability Center on Mathematics at the Interfaces of Data, Models, and Decisions (Department of Energy, \$16.7M total budget over 5 years). Lead PI, Dynamic Data Driven Methods for Self-aware Aerospace Vehicles (Air Force Office of Scientific Research, \$2.5M total budget over 6 years). Lead PI, Towards Scalable Differentiated Instruction using Technology-Enabled Competency-Based Dynamic Scaffolding (Department of Education, \$2.9M total budget over 4 years).

Administrative: Director of the Oden Institute for Computational Engineering and Sciences at UT Austin (2018-present). Oversees Oden Institute operations involving >350 people, >\$80M in active research contracts/grants, and >\$150M endowment funding. Served as the founding co-director of the MIT Center for Computational Engineering (2008-2018) and the Associate Head of the MIT Department of Aeronautics and Astronautics (2011-2013). In Associate Head role, led reforms in the undergraduate degree program and put in place initiatives that successfully increased undergraduate enrollment in aerospace engineering.

Professional: Active professional service and leadership through multiple conference organizing committees, conference chair positions, technical committee leadership, organizational review committees, advisory boards, and editorial positions.

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Selected Awards and Honors

Best Paper Award, “Toward predictive digital twins via component-based reduced-order models and interpretable machine learning”, AIAA Multidisciplinary Design Optimization Best Paper, 2020

SIAM Student Paper Prize (E. Qian), “Multifidelity Monte Carlo estimation of variance and sensitivity indices,” 2020

Southwest Research Institute Best Student Paper Award (M. Kapteyn), “Toward predictive digital twins via component-based reduced-order models and interpretable machine learning,” AIAA Non-Deterministic Approaches Conference, Scitech Forum, 2020

Paper “Variance-based sensitivity analysis to support simulation-based design under uncertainty” one of the top 10 most accessed articles in *Journal of Mechanical Design* in 2019.

AIAA Fellow, Class of 2019

SIAM Fellow, Class of 2018

Conference on Neural Information Processing Systems (NeurIPS) paper “Contour location via entropy reduction leveraging multiple information sources” selected for Spotlight Presentation (3% of submissions), 2018.

Best Paper Award, “Towards a Low-Order Model for Transonic Flutter Prediction,” AIAA Theoretical Fluid Mechanics Conference, AIAA Aviation Forum, 2017

Member of the New Zealand Order of Merit (MNZM), 2017

Distinguished Alumni Award, University of Auckland, 2016

Member, Harvard Higher Education Leaders Forum, 2016 – 2019

SIAM SIGEST Award for paper “Goal-oriented inference: Approach, linear theory, and application to advection-diffusion,” 2013

Sir Peter Blake Trust Emerging Leader Award, 2010

Selected for National Academies Frontiers of Engineering Education Symposium, 2010

AIAA MDO Technical Committee Service Award, 2008 and 2013

J. T. Oden Faculty Research Fellow, University of Texas at Austin, 2006

New Zealand Management Magazine, Young Leader, 2006

MIT Junior Bose Teaching Award, 2005

MIT Department of Aeronautics and Astronautics Teaching Award, 2004

Best Paper Award, “A Framework for Aircraft Conceptual Design and Environmental Performance Studies,” AIAA Multidisciplinary Analysis and Optimization Conference, 2004