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Enhancing Communication & Collaboration in Interdisciplinary Research

*To the students whose resolve to transcend disciplinary thinking and insight
into how to do so have inspired and informed this volume.*

[Author: This title page is a placeholder; real version to come from art department.]

Enhancing Communication & Collaboration in Interdisciplinary Research

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Preface

Hofstadter's Law famously states: "It always takes longer than you expect, even when you take into account Hofstadter's Law."¹ Where the study of interdisciplinarity is concerned, one must acknowledge the corollary that not only does it take longer than you expect—it will be far harder and much more puzzling as well.

The editors of this volume initially came together as a result of an attempt to solve a small although not insignificant issue in interdisciplinary pedagogy at the University of Idaho. The issue: What is the best way to facilitate communication and collaboration between members of interdisciplinary research teams participating in the university's National Science Foundation–sponsored Integrative Graduate Education and Research Traineeship (IGERT) project? Seven years of hard work have generated insights and enlightenment, but much remains to be done with the issues that arose out of that initial "small" problem.

Our work on the nature of interdisciplinary communication and collaboration led us to organize an international conference on that topic that met in Coeur d'Alene, Idaho, from September 30 to October 2 of 2010. That conference, "Enhancing Communication in Cross-Disciplinary Research" (ECCDR), brought together experts in cross-disciplinary research, both practitioners and theorists, to discuss solutions to the communication challenges that confront collaborative research. The goal was to generate new ideas and useful insights about cross-disciplinary communication through robust conversation among cross-disciplinary research practitioners, specialists in the interdisciplinary process, and philosophers and sociologists of integrated science.

¹Hofstadter, D. (1999). *Gödel, Escher, Bach: An eternal golden braid* (20th anniversary ed.). Cambridge, MA: Basic Books, p. 152.

The essays in this volume began life as presentations at ECCDR. All presenters at the conference were encouraged to submit proposals for chapters that could be included in this collection, and after a process of peer evaluation, only a few were selected. We regret that we had to turn down numerous quality proposals, due to space limitations.

Acknowledgments

This volume is based on work supported by the National Science Foundation under Grant No. SES-0823058 and IGERT Grant No. 0114304. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation. We are also grateful to the Interdisciplinary Activities Grant program (College of Graduate Studies, University of Idaho) and the Fund for Interdisciplinary Teams (Environmental Science Program, University of Idaho) for project support that led to the production of this book.

As noted above, this volume originated in the ECCDR conference held September 30 to October 2, 2010, in Coeur d'Alene, Idaho. We are grateful to the University of Idaho, Boise State University, and the Coeur d'Alene Resort Hotel for assistance in planning and funding ECCDR. At the University of Idaho, we were supported by President M. Duane Nellis and his office, Katherine Aiken, Douglas D. Baker and his office, Kjelda Berg, Steven B. Daley-Laursen, Teresa Dillon, Barbara Ham, Melissa Erwin Jones, Douglas Lind, John K. McIver, Nathan Myatt, Virginia Pellegrini, Tania Thompson, and Kathleen Zillinger. Mark Rudin, the vice president for research at Boise State University, provided financial support for ECCDR. Scott Shellman at Framework Meetings was a critical part of making the meeting run smoothly. We are also grateful to Christoph Bellardi, Tricia Krisher, Kathy Larson, and the staff at The Coeur d'Alene Resort.

The members of the Toolbox Project have provided substantial assistance to us in preparing this volume: Nilsa Bosque-Pérez, Brian Crist, Ruth Dahlquist, Shannon Donovan, Troy E. Hall, Renée Hill, Justin Horn, Chris Looney, Ian O'Loughlin, Sara Pepper, Liela Rotschy, Brianne Tice Suldovsky, and our advisers Frank Davis, Paul E. Griffiths, and Julie Thompson Klein.

The Advisory Board contributed significantly to determining the approach to communication and collaboration that we have adopted. They also reviewed all the chapter proposals we received and advised us concerning which should become chapters in the volume. Once received, each chapter was evaluated in a blind process by several referees. We are grateful to those who contributed very useful critical commentary: Betsy Wackernagel Bach, University of Montana; Gabriele Bammer, Australian National University; Jan Boll, University of Idaho; Nilsa Bosque-Pérez, University of Idaho; Ingo Brigandt, University of Alberta; Adam Briggie, University of North Texas; Frank Davis, University of California, Santa Barbara; Bruce Glymour, Kansas State University; Michael E. Gorman, University of Virginia; Troy E. Hall, University of Idaho; Graham Hubbs, University of Idaho; Joann Keyton, North Carolina State University; Julie Thompson Klein, Wayne State University; Tim A. Kohler, Washington State University; Holly Falk-Krzesinski, Elsevier; William Newell, Miami University; Christian Pohl, ETH Zurich; Thomas P. Seager, Arizona State University; Matthew Slater, Bucknell University; Daniel Stokols, University of California, Irvine; David Stone, Northern Illinois University; Paul B. Thompson, Michigan State University; and Kyle Powys Whyte, Michigan State University.

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Finally, we are very grateful to our publisher at SAGE, Vicki Knight, and her staff for sharing our excitement about this project and for making it happen as painlessly as possible!

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About the Editors

Michael O'Rourke is professor of philosophy and faculty in AgBio-Research at Michigan State University. His research interests include environmental philosophy; the nature of epistemic integration and communication in collaborative, cross-disciplinary research; and the nature of linguistic communication between intelligent agents. He is director of the Toolbox Project, a NSF-sponsored research initiative that investigates philosophical approaches to facilitating interdisciplinary research. He was principal investigator on the NSF-funded project "Improving Communication in Cross-Disciplinary Collaboration" (SES-0823058), which extended the development and application of the "Toolbox" method designed to improve communication and understanding among members of cross-disciplinary research teams. He has published extensively on the topics of communication, interdisciplinary theory and practice, and robotic agent design. He has been a coprincipal investigator or collaborator on funded projects involving autonomous underwater vehicles, biodiversity conservation, sustainable agriculture, and resilience in environmental systems. He cofounded and served as codirector of the Inland Northwest Philosophy Conference, an interdisciplinary conference on philosophical themes, and as coeditor of the Topics in Contemporary Philosophy series published by MIT Press.

Stephen Crowley is an associate professor of philosophy at Boise State University. He is a graduate of Indiana University (Bloomington), where he was part of a rich interdisciplinary community (philosophers, computer scientists, psychologists, and biologists) working on issues in animal cognition. He was also a founding member of the Indiana University Philosophy Department's Empirical Epistemology Laboratory—a group focused on applying methods from the social sciences to issues within the theory of knowledge in particular as well

as philosophy more generally. Since arriving at Boise State, Stephen, while continuing to work on providing a coherent intellectual framework for empirical philosophy, has focused his research on developing an understanding of the barriers to and mechanisms for conducting interdisciplinary collaborative research. Some of this work involves agent-based modeling, but the major focus has been on empirically informed investigation with the Toolbox Project (<http://www.cals.uidaho.edu/toolbox/>) at the University of Idaho. As a side project, Steve spends time wondering why things are so much easier in theory than in practice when it comes to interdisciplinary collaboration!

Sanford D. Eigenbrode is professor and chair of entomology at the University of Idaho. He received a BS in biology, an MS in natural resources, and a PhD in entomology from Cornell University. Sanford conducts research on chemical ecology of insect–plant and multitrophic interactions. He has expertise in host plant resistance, natural products chemistry, scanning electron microscopy, and integration of host plant resistance into insect pest management. Recently, he has focused on the chemical ecology, landscape ecology, and management of insect-vectored viruses of wheat, potatoes, and legumes. He is director of an AFRI RAMP project on legume virus risk mitigation. His landscape ecology research has included study of insect pests affecting coffee agroforestry systems in Costa Rica. He is coprincipal investigator on a renewed NSF-IGERT project on Resilience of Ecological and Social Systems in Changing Landscapes and coordinator of the Joint Doctoral Program between the University of Idaho and CATIE (Tropical Agricultural Research and Higher Education Center) in Turrialba, Costa Rica. He is project director for a \$20-million NIFA Coordinated Agricultural Project on Regional Approaches to Climate Change in Pacific Northwest Agriculture and a NIFA-funded Risk Avoidance and Mitigation program. As an outgrowth of these broadly interdisciplinary, collaborative projects, Sanford is engaged in research and education focused on improving the process of collaborative science, which continues to thrive through his engagement with the ECIR volume and the project that has produced it.

J. D. Wulforst is professor of rural sociology and chair of the board of advisors for the Social Science Research Unit at the University of Idaho. He received a BA in interdisciplinary studies from Appalachian State University, an MS in sociology from the University of Kentucky, and a PhD in rural sociology from Utah State University. He has expertise in risk perceptions, constraints to adoption of technology in farm systems, conflict in rangeland management, and the negotiated order(s) of natural resource management. Recently, he has begun work in the area of climate science related to agricultural systems, societal adaptation, and community resilience. He has developed a niche as a social scientist collaborating with interdisciplinary teams addressing natural resource and agricultural challenges within the western United States. As a member of this editorial team, J. D. has developed an interest in team-based research processes, especially with respect to how social dynamics affect groups with turnover and institutional change.

About the Contributors

Gabriele Bammer is a professor at The Australian National University (ANU). She is developing the new discipline of Integration and Implementation Sciences (I2S) to improve research strengths for tackling complex real-world problems through synthesis of disciplinary and stakeholder knowledge, understanding and managing diverse unknowns, and providing integrated research support for policy and practice change (see <http://i2s.anu.edu.au>). This is described in her latest book, *Disciplining Interdisciplinarity: Integration and Implementation Sciences for Researching Complex Real-World Problems* (ANU E Press, 2013). She is director of the Research School of Population Health and of the National Centre for Epidemiology and Population Health, ANU College of Medicine, Biology and Environment. She is also an ANU public policy fellow, a research fellow at the Program in Criminal Justice Policy and Management at Harvard University's John F. Kennedy School of Government, and the convenor of the ARC Centre of Excellence in Policing and Security's Integration and Implementation research program.

L. Michelle Bennett is the deputy scientific director for the National Heart Lung and Blood Institute (NHLBI), National Institutes of Health. The NHLBI Intramural Research Program comprises intramural scientists and clinicians working in basic, translational, and clinical research. Dr. Bennett is responsible for scientific programmatic oversight, strategic planning, and implementing strategies to support the research mission. Previously, she was a deputy director at the CCR, NCI, where she developed and implemented projects and activities that cut across a broad range of scientific areas to accelerate research progress. She has been engaged in the practical aspects of facilitating collaboration, has extensive practical experience in promoting

team-based approaches by bringing together research scientists with diverse backgrounds and expertise to solve complex scientific problems. She has published works highlighting the fundamental characteristics that contribute to successful scientific team functioning, including a workbook, *Collaboration and Team Science: A Field Guide*, that serves as a primer for investigators who are building or participating on a research team. She has been invited to give numerous presentations, conduct workshops, and work with groups interested in learning to better implement successful strategies for building and sustaining scientific collaborations and research teams. She has experience working with people one-on-one and in teams to meet their individual objectives, overcome challenges, and improve their group dynamics for successful team functioning.

Stuart Blythe is an associate professor of rhetoric and writing at Michigan State University. His research interests include technical communication and the intersections of public and expert discourse on environmental policy.

Daniel Boden is a doctoral candidate at the Center for Public Administration and Policy at Virginia Tech. He holds a master's degree in public administration from Virginia Tech and a bachelor's degree in history from Brigham Young University. His current research interests are higher education policy, organization theory, and collaborative management.

Richard D. Boone is professor of ecosystem ecology in the Department of Biology and Wildlife and the Institute of Arctic Biology at the University of Alaska Fairbanks. He received his BA in biology from Oberlin College, MS in forest ecology from Oregon State University, and PhD in forest soils from the University of Massachusetts, Amherst. Boone served as chair of the Department of Biology & Wildlife from 2006 to 2010 and as associate dean of undergraduate studies in the College of Natural Science and Mathematics from 2010 to 2011. During his tenure as chair he promoted and facilitated a shift in instruction from lecturing to a blended approach with active learning. He also served as the principal investigator of an NSF-funded GK-12 project that pairs STEM graduate students (fellows) with K-12 teachers and their students over a full academic year; the fellows gain teaching and communication skills and bring their research and inquiry-based approaches to the K-12 classroom. Currently, Boone is serving as a program director in the Integrative Graduate Education and Research Traineeship program at the U.S. National Science Foundation. Professional interests include stimulating a shift in STEM graduate student education from an apprenticeship model to a traineeship model that emphasizes the broader professional development of graduate students. Boone was appointed as an Aldo Leopold Leadership Fellow in 2001 and a National Academies Education Fellow in the Life Sciences in 2007.

Maura Borrego is an associate professor and former director of the Graduate Program in the Department of Engineering Education at Virginia Tech, currently serving as a program director in the Division of Undergraduate

Education at the National Science Foundation. She recently held a 2010–2011 AAAS Science & Technology Policy Fellowship at the National Science Foundation. Dr. Borrego’s research interests focus on interdisciplinary faculty members and graduate students in engineering and science. Dr. Borrego holds a U.S. NSF CAREER Award and Presidential Early Career Award for Scientists and Engineers for this research. She is an editorial board member for *Journal of Engineering Education* and chair of the American Society for Engineering Education’s Educational Research and Methods Division. All Dr. Borrego’s degrees are in materials science and engineering. Her MS and PhD are from Stanford University, and her BS is from University of Wisconsin–Madison.

Nilsa A. Bosque-Pérez is a professor of entomology and 16-year member of the University of Idaho College of Agricultural and Life Sciences faculty. She directs the university’s National Science Foundation–funded Interdisciplinary Graduate Education and Research Traineeship program, which funds interdisciplinary teams of students and faculty working on resilience of social–ecological systems in Idaho and Costa Rica. The program has created a unique team-based interdisciplinary graduate educational model that has received recognition across the country. She is also a member of the Toolbox Project and has been engaged in interdisciplinary research and graduate education throughout her career. She additionally conducts research on plant–virus–vector interactions, host plant resistance to insects, and the impact of diverse land uses and management practices on insect pollinators of plants.

Steve Bosserman is the founder of Bosserman & Associates, Inc., a management consulting firm specializing in strategic framing and organizational design. Steve enables clients to tap emerging trends in markets, technologies, and work and to develop business initiatives that increase stakeholder participation, rate of innovation and adaptation, and commercialization of products and services. His deliverables include convening and moderating networks, communities, and teams to be more responsive in the face of opportunities; coaching leaders on how to improve their decision making in conjunction with organizational culture and performance metrics; and guiding members to be more consequent and intentional with their communications both within and outside the organization. During the 1994 to 2001 period, Steve cofounded WorkSpan, Inc.—a consulting firm specializing in systems change strategies for land-grant universities, foundations, government agencies, and professional societies. Services included delivery of leadership for institutional change workshops; development of internal strategies for change predicated on convening and facilitating conversations that would not occur otherwise; and coaching of individuals/teams dedicated to influencing organizational performance. Steve’s recent focus is in sustainable local economic development and community self-reliance through the introduction of value network structures, value accounting systems, and complementary currencies.

Sarah E. Cornell is an environmental scientist with a research background in global environmental dynamics and a strong interest in improving ways to integrate different discipline-based knowledges about the world we live in. She currently coordinates the steadily expanding Planetary Boundaries Research Network, an international collaboration initiative for global sustainability led by the Stockholm Resilience Centre. In her previous role, she was the science manager and synthesis leader for the UK Natural Environment Research Council's £23-million program *Quantifying and Understanding the Earth System*. She established the United Kingdom's first master's programme in earth system science at the University of Bristol, which aimed explicitly at providing transdisciplinary training and learning. Sarah has also worked in environmental consultancy and policy roles, including as sustainability advisor to a UK government cabinet member and as a contributor to the United Kingdom's Foresight projects. These experiences underpin her view that there is no substitute for deep and gritty dialogue in building good interdisciplinary understandings.

Michael M. Crow became the 16th president of Arizona State University (ASU) on July 1, 2002. He is guiding the transformation of ASU into one of the nation's leading public metropolitan research universities, an institution that combines the highest levels of academic excellence, inclusiveness to a broad demographic, and maximum societal impact—a model he designed, known as the “New American University.” Under his leadership, ASU has established major interdisciplinary research initiatives such as the Biodesign Institute, Global Institute of Sustainability, and more than a dozen new transdisciplinary schools, and witnessed an unprecedented academic infrastructure expansion, tripling of research expenditures, and attainment of record levels of diversity in the student body. Crow was previously executive vice provost of Columbia University, where he served as chief strategist of Columbia's research enterprise and technology transfer operations. He has been an advisor to the U.S. Departments of State, Commerce, and Energy, as well as defense and intelligence agencies, on matters of science and technology policy in areas related to intelligence and national security. He is a fellow of the American Association for the Advancement of Science and National Academy of Public Administration, and a member of the Council on Foreign Relations and U.S. Department of Commerce National Advisory Council on Innovation and Entrepreneurship. He is the author of books and articles analyzing science and technology policy and the design of knowledge enterprises. Crow received his PhD in public administration (science and technology policy) from the Maxwell School of Citizenship and Public Affairs, Syracuse University.

William B. Dabars is research fellow for University Design in the Office of the President, Arizona State University. He has served in various research capacities for the University of Southern California, University of California, Santa Barbara, and Getty Research Institute, where he participated in editorial

projects focused on aesthetic and architectural theory. He has also served as an editorial consultant for the Getty Conservation Institute and University of Colorado, Boulder. He received a PhD in history from the University of California, Los Angeles. His dissertation, publications, and current research focus on the American research university.

Shannon Donovan received her BS in wildlife management from the University of New Hampshire, her MS in recreation, parks and tourism resources from West Virginia University, and her PhD in environmental science from the University of Idaho (UI). At UI, she served as a National Science Foundation Integrative Graduate Education and Traineeship fellow working on two interdisciplinary projects designed to craft conservation strategies for the Volcánica Central de Talamanca Biological Corridor of Costa Rica and the Palouse region of the Inland Northwest. Shannon has served as both a post-doc and affiliate researcher for the UI Toolbox Project. She is currently an assistant professor of environmental studies at the University of Alaska. She is currently working on the forest plan revision process with the Chugach National Forest and researcher food security issues and needs within the state of Alaska. Outside of work, Shannon can be found playing outdoors with her son and husband.

Robert Frodeman (PhD, philosophy; MS, geology) is professor of philosophy and former chair of the Department of Philosophy and Religious Studies at the University of North Texas (UNT), where he specializes in environmental philosophy, the philosophy of science policy, and the philosophy of interdisciplinarity. He served as a consultant for the U.S. Geological Survey for 8 years, was the 2001–2002 Hennebach Professor of the Humanities at the Colorado School of Mines, and was an ESRC fellow at Lancaster University in England in the spring of 2005. In addition to more than 80 published articles and \$1.8 million in federal grants, Frodeman is the author and/or editor of nine books, including *Geo-Logic: Breaking Ground Between Philosophy and the Earth Sciences* (SUNY, 2003), the *Encyclopedia of Environmental Ethics and Philosophy* (MacMillan, 2008), and the *Oxford Handbook of Interdisciplinarity* (OUP, 2010). Frodeman is the founding director of the Center for the Study of Interdisciplinarity at UNT (www.csid.unt.edu).

Howard Gadlin has been ombudsman and director of the Center for Cooperative Resolution at the National Institutes of Health since the beginning of 1999. From 1992 through 1998 he was university ombudsperson at UCLA. He was also director of the UCLA Conflict Mediation Program and codirector of the Center for the Study and Resolution of Interethnic/Interracial Conflict. While in Los Angeles, Dr. Gadlin served as consulting ombudsman to the Los Angeles County Museum of Art. Prior to coming to UCLA, Dr. Gadlin was ombudsperson and professor of psychology at the University of Massachusetts, Amherst. At present, Dr. Gadlin is studying the dynamics of scientific teams and collaborations and developing new approaches to

addressing conflicts among scientists. An experienced mediator, trainer, and consultant, Dr. Gadlin has years of experience working with conflicts related to race, ethnicity, and gender, including sexual harassment. Currently, he is developing new approaches to addressing conflicts among scientists. He is often called in as a consultant/mediator in “intractable” disputes. Dr. Gadlin has designed and conducted training programs internationally in dispute resolution, sexual harassment, and multicultural conflict. Dr. Gadlin is the author of, among other writings, “Bargaining in the Shadow of Management: Integrated Conflict Management Systems,” “Conflict, Cultural Differences, and the Culture of Racism,” and “Mediating Sexual Harassment.” He is the coauthor of “Neutrality: What an Organizational Ombudsperson Might Want to Know” and “Conflict Resolution and Systemic Change.” Most recently, he has coauthored “Collaboration and Team Science: A Field Guide.”

Ardyth H. Gillespie is an associate professor in the Division of Nutritional Sciences at Cornell University, where she coleads the Family and Community Food Decision-Making Program with community-based partners. Along with her research on the processes and pathways of family and community food decision making, she has focused on developing methodology for advancing transdisciplinary research on the complex relationships and dynamics of changing both food systems and food and eating practices and for integrating research with campus education and community-based practice. Developers and practitioners of this evolving methodology, called collaborative engaged research (CER), seek to improve health and well-being of children, youth, and their families by fostering thoughtful, collective food decision making in families and communities. Through CER, Gillespie and her collaborators engage families and community change agents, students, and scholars in building local capacity for collective decision making and for generating and applying new knowledge about family and community food decision-making systems. Gillespie is a past president of the Society for Nutrition Education and Behavior and currently a faculty fellow in the David R. Atkinson Center for a Sustainable Future at Cornell University. Gillespie is also a collaborator faculty member at Iowa State University and coleader of the Harrisdale Homestead CER Leadership Institute.

Paul E. Griffiths was educated at University of Cambridge and Australian National University (ANU), receiving his doctorate from ANU in 1989. After teaching in Australia and New Zealand, he moved to the University of Pittsburgh in 2000, returning to Australia in 2004 as an Australian Research Council Federation fellow. Currently, he is based at the University of Sydney, where he is university professorial research fellow in the Department of Philosophy and associate academic director for humanities and social sciences at the Charles Perkins Centre, a multidisciplinary research institute focused on obesity, diabetes, and cardiovascular disease. He is also a visiting professor in the ESRC Centre for Genomics in Society at the University of

Exeter, United Kingdom. He is a fellow of the American Association for the Advancement of Science; fellow of the Australian Academy of the Humanities; president of the International Society for History, Philosophy and Social Studies of Biology; and from 2006 to 2012 was a member of the Australian Health Ethics Committee of NHMRC.

Casey Hoy is a professor and former associate chairman of the Ohio State University Department of Entomology and has held the Kellogg Endowed Chair in Agricultural Ecosystems Management since 2006, providing leadership to the interdisciplinary Agroecosystems Management Program. He received both BS and PhD degrees in entomology from Cornell University. Casey's past research has included systems analysis and its application to integrated pest management and applied ecology. His current work is developing the theoretical and applied knowledge base essential to advancements in agroecosystem health and sustainable agricultural communities. Casey also leads development of sustainable agriculture degree programs in Ohio and outreach focused on building social networks that promote entrepreneurship in diverse agricultural enterprises. His recent service includes various federal grant review panels, the Ohio Food Policy Advisory Council, the Cuyahoga Valley Countryside Conservancy Board of Trustees and the executive committee for the Inter-institutional Network for Food and Agricultural Sustainability, a Kellogg-endowed national network of agriculture and food system leaders. Together with his coauthors, Casey hopes to continue developing practical approaches for pursuing interdisciplinary as well as intercultural communication challenges and opportunities.

Julie Thompson Klein is professor of humanities in the English Department and faculty fellow for Interdisciplinary Development in the Division of Research at Wayne State University. She has also held appointments as visiting foreign professor in Japan, Fulbright lecturer in Nepal, foundation visitor at the University of Auckland, New Zealand, and Mellon fellow and visiting professor of digital humanities at the University of Michigan. In addition, she was senior fellow at the Association of American Colleges and Universities and the Center for the Study of Interdisciplinarity. Holder of a PhD in English from the University of Oregon, Klein is past president of the Association for Interdisciplinary Studies (AIS) and former editor of the AIS journal. Her books include *Interdisciplinarity: History, Theory, and Practice* (1990); *Interdisciplinary Studies Today* (coedited, 1994); *Crossing Boundaries: Knowledge, Disciplinarity, and Interdisciplinarity* (1996); *Transdisciplinarity* (coedited, 2001); *Interdisciplinary Education in K-12 and College* (edited, 2002); the monograph *Mapping Interdisciplinary Studies* (1999); *Humanities, Culture, and Interdisciplinarity* (2005); and *Creating Interdisciplinary Campus Cultures* (2010). She was also associate editor of the *Oxford Handbook on Interdisciplinarity* (2010). Klein has received awards at Wayne State University and was honored with the Kenneth Boulding Award for outstanding scholarship on interdisciplinarity, Yamamoorthy & Yeh Distinguished

Transdisciplinary Achievement Award, and Joseph Katz Award for Distinguished Contributions to General and Liberal Education. She is currently coeditor of the University of Michigan Press series Digital Humanities@digitalculturebooks and is completing a new book on mapping digital humanities.

Benson P. Lee is the founding CEO of Technology Management, Inc., which is commercializing systems solutions based on a proprietary, kilowatt-scale solid oxide fuel cell technology acquired from BP. He received his BEE and master's certificate in engineering from Cornell University and completed all coursework for his MBA and PhD at the NYU Graduate School of Business. After working in industry for IBM and Westinghouse, he founded Bioelectron, which successfully commercialized a medical device to heal broken bones using electricity. As a practicing social entrepreneur, he is experienced using private-sector solutions to solve public-sector problems at the formative stages, where entrepreneurial championship, innovation, and invention have the greatest impact. His interdisciplinary approach evolved from decades of problem solving on nonprofit boards, including Cornell University, where he is an Emeritus Trustee, and the Cleveland Foundation, the world's first community foundation with assets of more than \$2 billion, and on visiting committees for technology commercialization, engineering, business, and sustainability for Cornell, University of Pennsylvania, and locally for Case Western Reserve and Cleveland State and Baldwin Wallace universities. He is currently committed to the commercialization of fuel cells for distributed generation as a new industry and for distributed infrastructure where fuel cells, converting indigenous renewable biofuels into electricity, can sustain economic development, improved public health, and affordable local services for 4 billion people living without electricity. His goal is to demonstrate competitive economic returns from a scalable social enterprise business using hybrid financing from public, private, and philanthropic sources, for replication by other social entrepreneurs.

Arika Ligmann-Zielinska is an assistant professor in the Department of Geography and Environmental Science and Policy Program at Michigan State University. She is a PhD graduate from a Joint Doctoral Program in Geography at San Diego State University and University of California Santa Barbara. She got her MS in geography from Adam Mickiewicz University in Poznan, Poland. Her research activities encompass a broad range of modeling approaches that capture the dynamic relationships within coupled human and natural systems. To date, her core research has focused on agent-based modeling of land use change and water quality in various exurban areas across the United States. She has also pioneered spatiotemporal sensitivity analysis of model output. This exploratory technique allows for partition model outcome variability such that the underlying causes of the simulated emerging phenomena (like urban land development, water pollution, and deforestation) can be identified and adequately addressed. As part of her teaching agenda, Arika has contributed to the development of a modeling

curriculum at Michigan State University. She has also coauthored a modeling workbook titled “Agent Analyst: Agent-Based Modeling in ArcGIS,” which exposes students to the theoretical as well as practical challenges in integrative agent-based model building.

Chris Looney is an entomologist with the Washington State Department of Agriculture. Dr. Looney’s research has focused on the diversity and conservation of epigeal beetles, gall-inducing wasps, and native bees in eastern Washington State. He has also participated in interdisciplinary research exploring social and biophysical dimensions of conservation in fragmented, working landscapes and approaches to improving communication within interdisciplinary research teams. His current projects include documenting the spread of exotic Lepidoptera pests in Washington State and building an online information and resource center for Pacific Northwest sawflies.

Ross B. MacDonald is a research scientist in the Ohio State University Department of Entomology, providing leadership in curricular and program development. He holds a BA degree in English literature from the University of California at Berkeley, an MA degree also in English literature from California State University at Chico, and an individual major PhD in instructional communication from the University of California at Davis. He is the former director of the Program in Science and Society in the College of Agricultural and Environmental Sciences at UC Davis and has also worked with several nonprofit organizations on peace and justice issues in Haiti, Iran, and the Basque Region of Spain. His specialty is issue-based learning and action achieved through collaborations with diverse partners across cultures and disciplines. He is also known for his extensive work on behalf of postsecondary tutoring programs. Ross continues to work with creative individuals to develop innovative curricular approaches to address important contemporary issues at the intersection of science and society.

Sandra Marquart-Pyatt is an associate professor of sociology and environmental science and policy at Michigan State University. Her research interests are in the areas of comparative social change, environmental sociology, political sociology, and quantitative methods. Her current work focuses on identifying cross-national patterns on an array of environmental attitudes, beliefs, behavioral intentions, and behaviors that include climate change, general concern for the environment, and sustainability. She has published numerous articles on the application of advanced quantitative techniques to pressing global social issues related to the environment and politics, including environmental concern, democratic values, and views of the state. She is coauthor of the monograph *Nonrecursive Models: Endogeneity, Reciprocal Relationships and Feedback Loops* in the SAGE series *Quantitative Applications in the Social Sciences*. She has also been an instructor in the Inter-University Consortium for Political and Social Research’s Summer Program in Quantitative Methods at the University of Michigan for a graduate seminar on simultaneous equation models.

Wayde C. Morse is an assistant professor in the School of Forestry and Wildlife Sciences at Auburn University. He received his PhD in 2007 from the University of Idaho, Department of Conservation Social Sciences and from the Center for Tropical Agricultural Research and Higher Education in Costa Rica. The combined degree is the result of an innovative multi-institutional program funded by the National Science Foundation's Integrative Graduate Education and Research Traineeship. Morse's research interests include linked social-ecological systems, conservation decision making and behavior, ecosystem services, issues of scale, volunteer tourism, and outdoor recreation in the United States and Latin America. He has research projects in Costa Rica, Guatemala, and Ecuador, and throughout the southern United States. Morse has been a guest editor for a special issue in the journal *Urban Ecosystems* and has been an associate editor for the journal *Society and Natural Resources*. He currently serves on the Alabama Trails Commission.

M. Duane Nellis is the president of the University of Idaho. As the chief executive officer of Idaho's nationally recognized research and land-grant university, he is responsible for nearly 14,000 employees and students as well as a budget in excess of \$453 million. That responsibility extends to more than 70 education, research, and extension facilities. He serves as a commissioner for the Northwest Commission of Colleges and Universities and the Western Interstate Commission for Higher Education. He has also held other leadership positions and continues to be active in other national and international bodies, including the Association of Public and Land-Grant Universities; the Association of American Geographers; the National Council for Geographic Education; and Gamma Theta Upsilon, the international geographic honor society. Previously, he served as provost and senior vice president at Kansas State University. He also served as dean of the Eberly College of Arts and Sciences, West Virginia University's largest academic college. He also has been recognized for his research and teaching by the Association of American Geographers and the Institute of British Geographers. In addition, he is a fellow of the American Association for the Advancement of Science.

Laura Schmitt Olabisi is an assistant professor at Michigan State University, jointly appointed in the Environmental Science & Policy Program, and the Department of Community, Agriculture, Recreation, and Resource Studies. She is a systems ecologist and modeler, often working directly with stakeholders using participatory model-building techniques. Laura's past and present research has addressed soil erosion, population growth, greenhouse gas emissions, water sustainability, energy use, deforestation, adoption of organic/sustainable agricultural techniques, climate change and human migration, and climate change and human health. Laura holds a BS in environmental science from Brown University and a PhD from the State University of New York College of Environmental Science and Forestry. Prior to

her appointment at Michigan State, she worked as a postdoctoral researcher with the Ecosystem Science and Sustainability Initiative, housed at the University of Minnesota. Together with coauthors Arika Ligmann-Zielinska and Sandra Marquart-Pyatt, Laura is helping create a master's level environmental modeling certificate at Michigan State, which will be offered beginning in fall semester 2013.

Jenneth Parker, PhD (Sussex), Msc (LSE), BA (Cardiff), Cert Ed, is a research director at the Schumacher Institute, dedicated to 'putting people at the heart of a sustainable economy'. She has a background in philosophies of science, social science, and ethics, which underpins her approach to transdisciplinary research on sustainability. She has undertaken policy work for UNESCO and the European Union. She is currently working on the transdisciplinary critique and synthesis aspects of the EU Framework Programme 7-funded CONVERGE project. In addition to her academic qualifications, she is a qualified adult and community educator and experienced facilitator in participatory planning events.

David Pietrocola is a robotics and software engineer with a variety of experiences in research, government, and industry. During his 18-month appointment at the National Science Foundation, David served as the analyst for the IGERT program in the Division of Graduate Education. His contributions spanned a variety of projects and initiatives, a portfolio analysis of the IGERT program, a report to Congress on communication of science training for IGERT trainees, and a forthcoming NSF report on recent trends and outcomes from IGERT awards. David earned an MS in systems engineering from the University of Pennsylvania and a BS in electrical engineering with honors and Phi Beta Kappa from Trinity College in Hartford, Connecticut. He has published and presented peer-reviewed research in several areas, including autonomous mobile robots, agent-based modeling, virtual agents, human behavior modeling, serious games, digital copyright laws, and graduate education. He has helped develop several award-winning autonomous robots for outdoor navigation in uncertain environments and has been an organizer for the Trinity College Fire-Fighting Home Robot Contest since 2006. He is a member of IEEE, the IEEE-USA Intellectual Property Committee, and the IEEE-USA Research and Development Committee.

Melur K. Ramasubramanian is D. W. Reynolds Professor of Mechanical Engineering and department chair at Clemson University, South Carolina. He also holds a joint faculty position in bioengineering. Prior to that, he was most recently program director for the Integrative Graduate Education and Research Traineeship program at the National Science Foundation from July 2009 to 2012 and a professor of mechanical and aerospace engineering, North Carolina State University, Raleigh, from 1994. In addition, he held an associate appointment with the Joint UNC-NC State Biomedical Engineering Department. He was the director of the Mechatronics Program

in Mechanical Engineering, jointly administered with Electrical and Computer Engineering, an interdisciplinary graduate program. He received his PhD in mechanical engineering from Syracuse University in 1987 and worked in Research and Development, Georgia Pacific Corporation, as a research associate from 1987 to 1994, when he joined NC State University as an assistant professor. He has a vibrant externally funded research program and currently advises two PhD students. His current research interests are in the area of biomimetics, microfluidics and tissue engineering, biomechatronics, and computational mechanics. Current research projects include mosquito biting mechanics and applications to painless microneedle design, microencapsulation of islets for xenotransplantation using 3-D microfluidics, implantable sensors (passive MEMS intraocular pressure sensor), near-bedside opto-fluidic sensors for blood agglutination detection, and computational mechanics. He is a fellow of ASME and TAPPI, and a senior member of IEEE and EMBS.

Liela Rotschy is a graduate student in linguistics at The Ohio State University, focusing on formal semantics and pragmatics. She has an MA in teaching English as a second language from the University of Idaho, where she became involved with the Toolbox Project in 2010. As a member of the project she has contributed to development of the translational health science and climate science applications of the Toolbox approach.

Carol F. Stoel is a program officer for the Interdisciplinary Graduate Education Research Traineeships program, the Science Master's Program, and for evaluation activities in the Division of Graduate Education in the Education and Human Resources Directorate of the National Science Foundation (NSF). She has been in the Graduate Division since 2004 and was the acting division director from June 2007 through February 2009. Prior to joining NSF in 2004, Ms. Stoel worked in the nonprofit and higher education sectors. She served as vice president of the Council for Basic Education and director of its Schools Around the World program, comparing student work and teacher development practices across nine industrialized countries; principal partner of the Education Trust at the American Association for Higher Education, developing K–16 partnerships; and director of the American Association for University Women's Foundation, funding graduate dissertation fellowships for U.S. and international women and developing the Eleanor Roosevelt Fund to attract more young women into science and engineering studies. At the University of Maryland's University College she served as vice chancellor and at Hood College as the associate provost and executive assistant to the president. From 1973 to 1984, Ms. Stoel served as deputy director and program officer for the Fund for Improvement of Postsecondary Education in the Department of Education. Her BA is from Connecticut College for Women and her MAT from Harvard Graduate School of Education.

Daniel Stokols is Chancellor's Professor in psychology and social behavior and planning, policy, and design at the University of California, Irvine

(UCI). He holds courtesy appointments in public health, epidemiology, and nursing sciences at UCI. Dr. Stokols served as director and founding dean of the School of Social Ecology at UCI between 1988 and 1998. He is coauthor of *Behavior, Health, and Environmental Stress* (1986) and coeditor of the *Handbook of Environmental Psychology* (1987), *Environmental Simulation* (1993), and *Promoting Human Wellness* (2002). Dr. Stokols is recipient of the Career Award from the Environmental Design Research Association and UCI's Lauds & Laurels Faculty Achievement Award. Stokols served as scientific consultant to the National Cancer Institute (NCI), Division of Cancer Control and Population Sciences, and as a member of NCI's Science of Team Science (SciTS) team between 2005 and 2011. He is currently a team science consultant for the National Academies Keck Futures Initiative. Stokols's research interests include (1) SciTS and factors that influence the success of transdisciplinary research and training programs; (2) the environmental psychology of the Internet, especially the ways qualities of virtual life affect people's behavior and well-being; (3) the health and behavioral impacts of environmental stressors such as traffic congestion, crowding, and information overload; (4) the application of environmental design research to urban planning and facilities design; and (5) the design and evaluation of community health promotion programs.

David A. Stone is the associate vice president for research and an associate professor of public health at Northern Illinois University. He holds two interdisciplinary degrees (MA and PhD) from the University Professors Program at Boston University, the former combining studies in law, psychiatry, and phenomenological philosophy, and the latter combining philosophy of science, philosophy of technology, substantivist economics, sociology of work, organizational behavior, cognitive science, and expert systems. Over the past 20 years, Dr. Stone has served as an academic research scientist (public policy, health services research, public health, and clinical medicine research) at the Harvard School of Medicine, the Harvard School of Public Health, the Tufts University School of Medicine, and Sheffield University (UK). He has also served as founding director of the South East European Research Center (Greece), founding director of the Boston Violence Prevention Project at the Harvard School of Public Health, cofounder of the Pediatric and Adolescent Research Center at Tufts University, and director of the Fenway Health Center Research Department in Boston. As an interdisciplinary researcher and team scientist, Dr. Stone has published and taught in clinical medicine, public health, health services research, health policy, philosophy, political science, and management. His most recent work employs Heidegger's hermeneutic phenomenology to examine the role of the tacit in interdisciplinarity.

Karola Stotz is an Australian research fellow in the Department of Philosophy at the University of Sydney. Her research contributes to a reconciliation of nature and nurture, a dualism that stands in the way of a full understanding

of development, evolution, and heredity. She has been instrumental in importing this debate into cognitive science and psychology (<http://nanu.dynalias.org>). Together with Paul E. Griffiths, she pioneered the use of “experimental philosophy” methods in the field of philosophy of science, analyzing the diversification of the gene concept in different research communities within contemporary biology (<http://representinggenes.org>). This work has received significant attention from biologists and was discussed in *Nature* (441: 398–401). More recently, she and her collaborators have turned their attention to the concepts of innateness and human nature. With Griffiths, she coauthored *Genetics and Philosophy* (Cambridge University Press, April 2013), which combines enthusiasm for the revolutionary impacts of molecular biology with a rejection of “genocentrism” and “reductionism”. By examining the molecular biology of the “environment”, it situates genetics in the developmental biology of whole organisms and reveals how the molecular biosciences have undermined the nature/nurture distinction. Other research areas that inform her approach are embodied, distributed and extended cognition, and animal minds.

Guan-Jen Sung is a PhD candidate in the Family and Community Food Decision-Making Program in the Division of Nutritional Sciences at Cornell University. During and after her undergraduate study in plant sciences at National Taiwan University, she was a research assistant in plant biotechnological studies at the Development Center for Biotechnology and in plant mitochondria origination research at the Academia Sinica of Taiwan. She connects her plant sciences background across disciplines with human nutrition and Taiwanese Chinese medicine for her advanced degrees. She studied antioxidants in lotus embryotic germination for her master’s training at Cornell and investigated food decision making about medicinal food use for her doctoral research there. She has engaged in various fields of practice. She was an education assistant at the Cornell Plantations and trained as a counselor at Cornell’s EARS (Empathy, Assistance & Referral Service). She is a certified registered dietitian of Taiwan. Her interests in developing cross-cultural communication methods as well as methodology in collaborative engaged research led her to the Toolbox Project and coauthoring of a chapter in this book, with Professor Ardyth H. Gillespie. She is currently writing her dissertation about perceptions on medicinal and medicated food use among Taiwanese immigrant families in the United States.

Rick Szostak is professor of economics at the University of Alberta, where he has taught since receiving his PhD in economics from Northwestern in 1985. He is also president of the Association for Interdisciplinary Studies. He is the author of 10 books and more than 30 articles, all interdisciplinary in nature. For decades, his research has focused on how to facilitate quality interdisciplinary research and teaching. Most recently, he has worked on developing a non-discipline-based universal classification system. This would not only help interdisciplinary researchers find relevant

works and ideas in other fields but would clarify the meaning of key concepts. Toward this end, he has published several articles in information science journals and elsewhere that justify and develop such a classification in general, and his Basic Concepts Classification in particular. He is coauthoring a book on interdisciplinary knowledge organization. His paper in this volume draws on his research in interdisciplinary classification to suggest guidelines for facilitating interdisciplinary communication.