Building Performance Evaluation (BPE) informs and enhances the usability and sustainability of building designs with lessons learned from evaluation of building performance throughout the building life cycle, from initial planning through occupancy to adaptive re-use. A key feature of BPE is that it examines design and technical performance of buildings alongside human performance criteria. That is, it seeks to examine facilities in order to determine whether they will work for the people that will use and occupy them. Rigorous BPE helps to improve design practice by providing feedback on the effectiveness of the choices made about the building to ensure that its design is optimised for stakeholders’ uses.

The overarching theme for Enhancing Building Performance is to present the next generation of BPE work. The book provides an updated systematic approach for BPE as well as chapters written by experts from around the world who demonstrate how to apply BPE to enhance building design. Topics covered include: evidence-based and integrative design processes, evaluation methods and tools, and education and knowledge transfer. In addition, case studies provide specific examples of how BPE has been used to study such things as the impact of workplace design on human productivity and innovation.

Written primarily for design professionals and facility managers who wish to use BPE to deliver improved building performance that is responsive to the needs of stakeholders, Enhancing Building Performance will also be of great value to researchers and students across a range of architecture and construction disciplines.
Enhancing Building Performance

Edited by

Shauna Mallory-Hill
Assistant Professor
Faculty of Architecture
University of Manitoba, Canada

Wolfgang F. E. Preiser
Professor Emeritus
School of Architecture and Interior Design
University of Cincinnati, USA

Chris Watson
Architect
Post-Occupancy Evaluation, New Zealand

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*Duncan A. Joiner*

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Contributors

Toru Ando is a deputy director of the Residential Building Office of the Mie Prefecture Government and also a student at Doctoral Course at Mie University Graduate School of Engineering. He played the leading role as a facility manager in the major renovation discussed his chapter, and is preparing a doctor’s thesis on the topic. He has presented a number of times at Architectural Institute of Japan conferences and the Japan Facility Management Promotion Association.

Clinton J. Andrews is Professor of Urban Planning and Policy Development and Director of the Rutgers Center for Green Building at the Edward J. Bloustein School of Planning and Public Policy, Rutgers University. Prior to arriving at Rutgers in 1997, he worked in the private sector as a mechanical engineer, and helped launch an energy policy simulation project at MIT and a science policy program at Princeton. He studied engineering and planning at Brown and MIT, respectively, and holds professional certifications in engineering, planning, and green building. His research investigates both the demand and supply sides of the energy equation, and the use of technical information in decision-making.

Maria Beatriz Barbosa got her bachelor’s degree in architecture and urbanism from the University of São Paulo and currently she is a graduate student at FAUUSP. She is also Technical Assistant on Operation Management of the São Paulo Subway Company, where she has worked since 1988. Her research focus is the evaluation of the accessibility conditions of signage and information systems in subway stations. She also coordinates the Brazilian Association of Technical Standards’ (ABNT) Study Committee on Communication Accessibility.

Sheri Blake is Professor, Department of City Planning, University of Manitoba, Canada. She holds a D.Eng (Arch) and M.Eng (Arch) from the University of Tokyo, Japan, and a B.E.S. (Arch) from the University of Waterloo, Canada. She is a member of the Canadian Institute of Planners, Planners Network, and the Association for Community Design. Published in Japan, Canada and the United States, she has also collaborated on several films produced and distributed by Sou International Ltd., Winnipeg, MB, Canada. She has received awards for teaching, research and outreach and provides technical support to inner city initiatives in Winnipeg.

Galen Cranz. Professor Cranz, PhD Sociology, University of Chicago, has taught social and cultural processes in architectural and urban design, including...

**Francis Duffy** CBE PPRIBA is an architect and is one of the Founders of DEGW, an international architectural practice which specializes in Workplace Design. He was President of the Royal Institute of British Architects (RIBA) 1993–1995 and was based in DEGW’s New York office 2001–2004 during which time he was a Visiting Professor at MIT. He currently a Visiting Professor at the Universities of Lancaster and Reading. He was made a Commander of the British Empire (CBE) in 1997.

**Lindsey Dugdill** is Professor of Public Health at the University of Salford. Her PhD investigated the design, implementation and evaluation of health interventions in the workplace. She has a specialist interest in researching physical activity in populations and recently led an academic team which conducted a systematic review for the National Institute of Health and Clinical Excellence, in the UK (NICE) which investigated the evidence of effectiveness of workplace physical activity interventions. She is currently on the editorial board for the *International Journal of Reflective Practice* and a co-editor for the *International Journal of Workplace Management*.

**Edward Finch** is Professor in Facilities Management at the University of Salford. He has a background of over 20 years of academic involvement in the discipline of Facilities Management (FM). In 2008 he was appointed as coordinator for CIB W070, an International Working Party in Facilities Management that forms part of the ‘Conseil International du Bâtiment’: a global network for international exchange and cooperation in research and innovation in building and construction to support improved building processes and performance of the built environment. He has a particular interest in the development of FM business tools and techniques that provide a behavioral and economic understanding of building use. Edward is also Editor-in-Chief of *Facilities* – a leading peer reviewed academic journal.

**Carlotta Fontana**, has a MA in Architecture, and a PhD in Architecture Technology. She is full Professor of Architecture Technology at the Politecnico
di Milano, head of the Course of Environmental Architecture, and she teaches at both the School of Architecture and Society and the School of Building Engineering. Her research focuses on methods and tools for interventions in the built environment, with special attention to building pathology, diagnostics, and evaluation of architectural heritage. Since the late 1970s, Fontana has been working as a designer, a consultant and a specialized journalist in restoration, reuse and rehabilitation projects.

**Anca Gosselink** studied Dutch Language and worked for 12 years at the Dutch Government Building Agency, in communication and joining studies with regard to sustainable buildings and working environments. Since 2001 she has been a researcher at the Center for People and Buildings. She works on research and decision support tools such as the Integrated Workplace Roadmap, the so-called Places and Activities model (PACT) – a computer model that counts the required number of work spaces per type of work space with the level of desk sharing, number of employees and activity patterns of employees as input – and the CIPB Accommodation Choice model. In 2006 she received her MSc in Organization, Culture and Management from the Utrecht University. Anca published papers on personalization at the workplace and on decision-making processes.

**Jan L. M. Hensen** is full professor in computational building performance simulation in the Department of Architecture, Building and Planning, Eindhoven University of Technology. His research and teaching focus on computational modeling and simulation for performance based design and operation of buildings while considering energy, indoor environment, building physics, building services and building integrated (renewable) energy systems. He is the immediate past-president of the International Building Performance Simulation Association (IBPSA), Fellow of the American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE) and has received several scientific and practice awards. He has authored or co-authored over 200 papers and more than 100 reports. He is on the editorial boards of *Building and Environment, Energy and Buildings, International Journal of Low-Carbon Technologies* and is the founding co-editor of the *Journal of Building Performance Simulation*.

**Martin Hodulak** is a workplace strategy consultant at Drees & Sommer, Stuttgart, Germany. He leads a team specialized in programming and workplace design for automotive, pharmaceutical and information technology industries, as well as for the educational sector. Besides working on projects, the past years have seen him refining and training methodologies for programming and workplace design within Drees & Sommer and as a visiting lecturer at the University of Applied Sciences in Bielefeld. Prior to working for Drees & Sommer, he worked as an architect and programming specialist for various architectural practices in Germany and the UK. He was trained as an architect at the University of Karlsruhe, Germany and the University of Bath, UK.
Yolanda M. D. Ikiz-Koppejan received her MSc in environmental psychology from the Eindhoven University of Technology (1995) and followed additional courses in management skills and real estate management. After ten years of working as a consultant in real estate and process management she joined the Center for People and Building in order to conduct research on the design and management of new working environments and to support accommodation change management. This job is being combined with consultancy work in her own YKA Consultancy firm. As such she tries to connect the academic world with practice and to stimulate evidence based reasoning. She is a co-developer and co-author of the CfPB Accommodation Choice model and published a number of professional papers on accommodating new ways of working.

César Imai has a bachelor’s degree in architecture and urbanism from the State University of Londrina, a master and doctoral degrees in Architecture and Urbanism from the University of São Paulo. Currently, he is an Adjunct Professor at the State University of Londrina. He has experiences working on the following topics: social housing, participatory design, POE, and three-dimensional models.

Duncan A. Joiner PhD(London) BArch(Hons)(Auckland) FNZIA RIBA LDINZ. Duncan Joiner was educated at the School of Architect, University of Auckland, and the Bartlett School of Architecture, University College London. For over 35 years he has combined creative design practice and research. He was New Zealand Assistant Government Architect (Design) for ten years from 1978 where he was responsible for Architectural Research as well as coordinating the design approach of 12 architectural offices nationwide. He was Chief Architect in Works Consultancy Services Ltd from 1988 to 1992, where he also directed the company’s design and research services. He then established his international design and research consultancy practice based in Wellington.

Duncan Joiner was Head of the Wellington School of Design from 1994, and in 1999 he was appointed first Pro Vice-Chancellor of the College of Design, Fine Arts and Music at Massey University. He returned to architectural practice in 2007 in the Wellington Office of Stephenson & Turner New Zealand Limited. He was appointed Chief Architect in the New Zealand Department of Building and Housing in 2009. As a practitioner, he is responsible for the design of some notable New Zealand buildings. He is a Fellow of the New Zealand Institute of Architects and a Life Member of Design Institute of New Zealand. His fundamental research into the social and cultural influences on the use of architectural space has continued over 35 years from his work at University College London. His publications include new approaches to the design of workplaces, new methods for design and delivery accountability, innovations in design briefing methods, and co-authorship of the internationally recognized New Zealand post-occupancy evaluation method for evaluating buildings in use.
Akikazu Kato is Professor of Architecture at Mie University Graduate School of Engineering, Japan. His appointment includes teaching and research responsibilities in the fields of architectural planning and facility management. Previous positions included faculty member of other national universities, and licensed architect at Kume Architects. He received his doctorate in Engineering from Nagoya University. He has published a number of books and refereed papers, and presented at various international symposiums. Also, he planned and designed a number of architecture works mostly in the healthcare field including those winning prizes as 1991 Minister of Health Award and 2001 Minister of Construction Award.

Kevin Kelly, AIA received a master’s degree in Architecture from Virginia Polytechnic Institute and a bachelor of science in Architecture from the Catholic University of America. He has 14 years of national and international private sector architectural practice, as well as 21 years with the General Service Administration’s Public Building Service. His private work includes national and international office design including the on-site architect for the core of Riyadh’s Diplomatic Center. Serving under Ed Feiner, FAIA, and the Former Chief Architect of GSA, he helped establish the GSA’s National Design Excellence Program. His interest in the importance of interior architecture started when he was in charge of design for GSA’s 115 child care centers. He has authored workplace articles including Towards a New Interior Architecture for the Corporate Real Estate Journal and was a co-author of WorkPlace Matters, Interior Basics, Sustainability Matters and in charge of the recent development of GSA’s on-line Workspace Solution’s Library (WSL) – a tool for GSA’s real estate and workplace design staff.

Mina Kitazawa is a starter facility manager at Nagano City Government Office. She received her Master’s Degree from Mie University Graduate School of Engineering, and the topic of her master’s thesis was the workplace environment in Japanese local government offices.

Ana J. G. Limongi França got her bachelor’s degree in architecture and urbanism from the University of São Paulo. She got her master’s degree at the same institution, working on the relationship between built environment and human behavior, post-occupancy evaluation and building performance assessment regarding the design process.

Shauna Mallory-Hill, PhD, MArch, B.E.S., is an assistant professor and researcher on the Faculty of Architecture at the University of Manitoba (U of MB). Mallory-Hill teaches and does research in the areas of building performance evaluation, building technology, environment and behavior, sustainable and universal design. Previous positions include Executive Director of the Canadian Institute for Barrier-Free Design (1992–1996). A LEED® Accredited Professional, Mallory-Hill is responsible for delivering the first
Contributors

CaGBC-sanctioned post-secondary courses in Canada and also sits on the Board of Directors of the Manitoba Chapter of the CaGBC. She currently sits on the Board of Directors for the Environmental Design Research Association (EDRA). Results of her work have been presented at EDRA since 1996 and published in several articles and book chapters.

Rodney C. McDonald (Toronto, Ontario, Canada) is President of McDonald & Hardess Sustainability Group Inc. He advises corporate and government leaders and orchestrates multi-disciplinary project teams to create solutions that focus on people, place and performance. Mr. McDonald has held positions in the private and public sectors, including Director of Environmental Strategy for a builder and property developer, Manager of Sustainable Strategy & Policy for a global architecture firm, Chief Building Official for a provincial/state government, and Sustainability & Standards Specialist for an electric utility. He has chaired or served as a member of boards and committees throughout Canada to help advance sustainability, green building, and energy efficiency. Mr. McDonald holds a Master of Arts in Environment and Management from Royal Roads University, and a Bachelor of Arts in Economics from the University of Manitoba. He has won awards from the Canada Green Building Council and Natural Resources Canada.

Rosaria Ono got her bachelor’s degree in architecture and urbanism from the University of São Paulo (USP), her master’s degree from the University of Nagoya (Japan) and PhD from USP. She is an Associate Professor at the Faculty of Architecture and Urbanism of USP and her research focuses on building safety, security and human behavior.

Sheila W. Ornstein got her bachelor’s, master’s and doctoral degrees in architecture and urbanism from the University of São Paulo, where she currently works as a Full Professor, teaching and carrying out research and consultation on POE, human behavior and architectural quality management. She is also a consultant for the Organisation for Economic and Co-Operation Development (OECD) and a fellow researcher at the National Council of Scientific Development and Technology, Brazil.

Eleftherios Pavlides, PhD, AIA. Professor Eleftherios Pavlides, Masters of architecture, Yale School of Architecture, PhD University of Pennsylvania. His research combines architectural and anthropological methodologies to examine inhabitant perceptions of architectural form and his publications have been well received as contributions to anthropology. He has been practicing and teaching architecture since 1978. His architecture students’ research projects 2002–2006 on wind turbine perceptions in Rhode Island has been credited for helping set a 15 percent wind electricity goal for the state. This was recognized by a Rhode Island Legislature vote and a Governor of Rhode Island commendation. He is currently working with Galen Cranz on a
textbook to introduce architecture students to the social sciences with a fieldwork component combining the methodologies of architecture and social sciences to investigate inhabitant experiences of buildings and landscapes.

Sonja Persram (Toronto, Ontario, Canada) is President and CEO of Sustainable Alternatives Consulting Inc., specializing in green building policy and market research and implementation strategies. Ms Persram is engaged in a campaign for the David Suzuki Foundation for regulatory change to enable municipal energy retrofit financing that remains with a property on sale, and is publishing three papers on this topic. She is an author of reports for the Canada Green Building Council, the International Initiative for a Sustainable Built Environment and Frost & Sullivan, and conducts research for Jerry Yudelson. Ms Persram has an Honors BSc., an MBA and is a LEED® Accredited Professional. She was awarded a 2010 Journalist’s Fellowship to Germany by the German Government facilitated by the USGBC, and served on the USGBC’s Social Equity Task Force.

Wolfgang F. E. Preiser is Professor Emeritus at the School of Architecture and Interior Design, University of Cincinnati, Ohio, USA. He holds a PhD from the Pennsylvania State University, masters degrees in architecture from Virginia Polytechnic Institute and State University and the Technical University of Karlsruhe, Germany, as well as the First State Exam from the Technical University in Vienna, Austria. He has lectured at over 150 universities, conferences, and organizations worldwide. He has published 17 books and 125 chapters and articles, on topics ranging from universal design, to facility programming, to building performance assessments. Preiser also serves on the editorial boards of major journals. Preiser has received many honors, awards, and fellowships, including the Progressive Architecture Applied Research Award and Citation, the 1999 EDRA Career Award, and the 2007 and 2010 EDRA Achievement Award.

Ashraf M. Salama holds BSc., MSc. and PhD degrees in Architecture. He is the Chair of the Department of Architecture and Urban Planning at Qatar University, and has held permanent, tenured, and visiting positions in Egypt, Italy, Saudi Arabia, the United Kingdom, and the United States. He was a reader in architecture at Queen’s University in Belfast and has worked with the Community Development Group of North Carolina State University for several years. He has published over 100 articles and book sections, and authored and co-edited six books on architectural education and design studio pedagogy. He is the co-convener of the education network of the International Association for People Environments Studies (IAPS), chief editor of the International Journal of Architectural Research (IJAR), collaborating editor of Open House International (OHI), board member of Time-Based Architecture International, and International Journal of Environmental Research and Public Health. He sits on the scientific boards of several international organizations,
and is an international jury member for the International Union of Architects (UIA) and the International Association for Human Habitat (IAHH).

**Henry Sanoff**, AIA, ACSA Distinguished Professor Emeritus, College of Design, North Carolina State University is widely published and known for his many books – including, *Democratic Design*, *School Building Assessment Methods, Schools Designed with Community Participation, Programming and Participation in Architectural Design; Community Participation in Design and Planning, Creating Environments for Young Children, Integrating Programming Evaluation and Participation in Design*, and *Visual Research Methods in Design*. He is the former USA editor of the Journal of Design Studies, and recognized as the principal founder of the Environmental Design Research Association (EDRA). His research has concentrated in the areas of school facilities, children's environments, community arts, community revitalization, and aging populations. Professor Sanoff has been a visiting lecturer and scholar at more than 85 institutions in the USA and abroad. He received the NCSU, Holladay Medal of Excellence, Phi Kappa Phi Faculty Achievement award, ACSA Architecture Distinguished Professor, ACSA Community Design award, Distinguished Fulbright award, Fulbright Senior Specialists award, and the EDRA Honor and Service Awards. Sanoff also won a Design award and a Post-Occupancy Evaluation award for the Davidson School and the Millis Elementary School from the School Construction News/Design Share Awards program.

**Monika Schill-Fendl** is head of a state building construction department Monika Schill-Fendl represents the Free State of Bavaria as client organization and is responsible for the project management of complex building tasks. She holds a Ph.D. and a Diploma in architecture from the Dresden University of Technology and the Second State Exam in architecture from the Free State of Bavaria. She has lectured at different universities and presented at several conferences. She has published a monograph, some book chapters, and a range of articles in the field of planning and design methods, total facility management, concerning healthcare, research and laboratory buildings. Since 2005, she has been a lecturer at the University of Applied Sciences Augsburg/Germany.

**Ulrich Schramm** is Professor in the Department of Architecture and Civil Engineering at the University of Applied Sciences in Bielefeld, Germany. His appointment includes teaching and research responsibilities in the field of mechanical equipment and facility management, for example, POE and Programming. Previous positions include Assistant Professor at the University of Stuttgart and POE/programming specialist with Henn Architects in Munich. He received his doctorate in Architecture from the University of Stuttgart and a post-doctoral fellowship from the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) for his stay at the University of Cincinnati as Visiting Professor of Architecture. Results of his
research within the International Building Performance Evaluation (IBPE) consortium have been presented at EDRA- and IAPS-conferences since 1995 and published in several articles and book chapters.

Jennifer A. Senick is Executive Director of the Rutgers Center for Green Building and a doctoral student at the Edward J. Bloustein School of Planning and Public Policy, Rutgers University. She is an experienced urban planner and was trained in Political Science, Economics and Public Policy from Bowdoin College (BA), the University of California, Los Angeles (MA) and the Rand Corporation, where she worked previously for seven years.

Fionn Stevenson is Professor of Sustainable Design at the School of Architecture in the University of Sheffield, UK. She has previously held academic positions in five other Universities in the UK. She holds a PhD from Dundee University, as well as a degree and masters from Cambridge University and is qualified as a professional architect. She has 25 years of practice, research and teaching experience and has lectured worldwide at numerous Universities, conferences and organizations. She helped co-found The Scottish Ecological Design Association in 1991 and was its chair for several years. She has written extensively on sustainable housing design, designed award-winning housing, and instigated major research into sustainable materials and POE in the UK. She also advises UK government agencies on domestic POE and currently chairs the UK Good Homes Alliance Technical Monitoring Group.

Theo J. M. van der Voordt is Associate Professor in Corporate and Public Real Estate Management at the Faculty of Architecture and a senior researcher at the Center for People and Buildings in Delft, the Netherlands. He holds a PhD (1992) from the Delft University of Technology and a masters degree in Civil Engineering (1974) from the same university. His research includes briefing and Post-Occupancy Evaluations of buildings, with a focus on usability. He developed design guidelines for health care centers, childcare centers, facilities for mentally retarded people, and housing and care for the elderly. His present research focuses on workplace strategies, tools to support decision making processes, and conversion of empty office buildings to new purposes. He is a (co-)author of over 25 books and 200 professional and academic papers (www.tudelft.nl/djmvandervoordt).

Jacqueline C. Vischer is an Environmental Psychologist who has authored several books and numerous articles and chapters on topics related to user psychology of the work environment. She has a bachelor’s and master’s in Psychology, and a PhD in Architecture from the University of California, Berkeley. She has run a consulting practice for many years, providing workspace assessment services to major government and corporate clients. She joined the University of Montreal as head of the new Interior Design program in 1998. In 2010 she was named Emeritus Professor by the University, and she continues
to direct the Groupe de Recherche sur les Environnements de Travail (GRET)/New Work Environments Group: www.gret.umontreal.ca.

Rotraut Walden's major fields of research are architectural psychology and organizational and work psychology. She holds a tenured position at the Institute for Psychology of the University of Koblenz, Germany, and has been a member of the Environmental Design Research Association (EDRA) since 1989. Her research focuses on building performance evaluation, the development of instruments for evaluating schools, universities, office buildings, and hospitals. She has presented her research results at international conferences and is an author, co-author or editor of seven German-language books including: Psychology and the Built Environment, Architectural Psychology – at Day Care Centers (2011) and one English-language book: Schools for the Future (2009). Her professorial dissertation on Architectural Psychology: School, University and Office Building of the Future, was published in 2008.

Chris Watson's architectural practice serves government, commercial and private clients. Since 1984 he has developed and applied POE methods in New Zealand, Australia and Europe. He has presented his POE process at schools of architecture and design in Europe, the Americas, Middle East and Australasia, and to industry and the Programme for Education Buildings of the Organisation for Economic Co-operations and Development headquarters in Paris.

Richard E. Wener is Professor of Environmental Psychology at the Polytechnic Institute of New York University, and a faculty affiliate of the Rutgers Center for Green Building. Professor Wener has conducted and written about post-occupancy evaluation for more than 30 years and recently was a Fulbright Scholar at the Vienna University of Technology studying the impact of occupant behavior on green buildings.

Anna Westlund is a LEED-accredited Interior Designer with a unique background of professional experience in the consulting engineering and interior design fields. She holds a master’s degree in Interior Design from the University of Manitoba and an undergraduate degree in Applied Science, Civil Engineering from Queen’s University. Anna is passionate about sustainability and the effect that indoor environments have on people's holistic health. Anna currently resides in Winnipeg, Canada and works for Friesen Tokar Architects + Landscape + Interior Designers.

Paul Wilson is a senior lecturer at the University of Salford, England. He has a master’s degree in Occupational Health and Fitness and is currently completing a professional doctorate in the development of cycle centers to enhance commuting. Paul is able to combine his academic awareness of physical activity behavior and the use of ecological models with his experiences
of creating a social enterprise dedicated to the development of active commuting through the creation of cycle commuting centers, bikecreche.co.uk. He has a particular interest in the design of the environment to support physical activity.

**Xinhao Wang** is a professor of Planning in the University of Cincinnati. He holds a Ph.D. in City and Regional Planning from the University of Pennsylvania. He teaches courses in Geographic Information System (GIS), environmental planning, statistics, and planning research methods. His research interests are environmental planning, and integrated applications of GIS, visualization, modeling, and other information technologies in planning and urban studies. Dr. Wang has received research funding from governments, industries, and foundations. Examples of his work are analysis of the spatial pattern of public housing recipients; the relationship between land use and water quality; and GIS-based modeling. Dr. Wang's publications and presentations can be found in various GIS, planning and environmental journals. Dr. Wang is the Interim Director of the School of Planning and the Co-Director of the Joint Center of Geographic Information System and Spatial Analysis at the University of Cincinnati.
This book is the result of a long-standing collaboration among the editors, as well as most of the chapter contributors. Going back to 1995, at the EDRA 36 Conference in Boston, the International Building Performance Evaluation (IBPE) consortium was formed by Wolfgang Preiser for the purpose of information exchange, methodological development and building new knowledge in the topic area of building performance. This led to the development of a pragmatic conceptual framework that reflects the building delivery and life cycle and phases in the world of design and construction.

Subsequently, building performance symposia were organized annually at the conferences of the Environmental Design Research Association (EDRA). The first tangible outcome of these symposia was the book Assessing Building Performance (Preiser and Vischer, 2005), which showcased the aforementioned conceptual framework for the first time in the context of real world applications and case studies from around the globe. The book subsequently was translated into Chinese, published in 2009 by China Machine Press and is in circulation among practitioners and academicians alike. It spawned a number of masters’ theses and doctoral dissertations in such countries as Canada, China, Germany, India, Indonesia, Korea, Saudi Arabia, Sweden, and the UK.

The present book is seen as a sequel to Assessing Building Performance. Enhancing Building Performance once again brings together practitioners, administrators, academicians, as well as consultants with cutting edge experience in this evolving field of Post-Occupancy Evaluation (POE) and Building Performance Evaluation (BPE) from around the world. They are from such countries as diverse as: Brazil, Canada, Germany, Italy, Japan, New Zealand, Qatar, The Netherlands, the United Kingdom and the United States. Apart from the somewhat modified and further developed conceptual framework for Building Performance Evaluation (BPE), this book has an entirely new set of case studies, as well as information on new evaluation methodologies and the integration of BPE in academic curricula. It is expected that translations into Japanese, Italian and other languages will follow, thus spreading the word about ways of enhancing building performance to all corners of the world.

The audience for this book

The audience of the book is envisioned as practitioners in the planning, design and construction industries, including consultants, researchers, government
agencies/organizations, facility managers, and design students interested in learning how to understand and learn from building performance.

Organization

This book is organized into five parts. Part I presents the history and process model of building performance evaluation (BPE). Parts II through V each highlight different aspects of BPE research and practice currently underway around the world. Each is explained in more detail below.

Part I

In Chapter 1 Mallory-Hill, Preiser and Watson describe BPE and trace the history and evolution of BPE from its origins in environment-behaviour research and post-occupancy evaluation, highlighting key milestones of the past 45 years. Chapter 2 provides an updated version of BPE process model.

Part II – Design Processes and Evaluation

Part II provides the reader with examples of how a critical aspect of BPE design process model, stakeholder participation and feedback, is key to improving building outcomes and identifying best practices. Building evaluation is set within the context of integrative design processes (IDP) for green buildings, commissioning, rating systems and other design tools.

Participatory briefing and design is explored in detail using both rural and inner city case studies. Patterns in occupant requests are noted in post-occupancy evaluation from many building types and pattern language is used to communicate and organize evaluation results.

Part III – Case Studies

In Part III readers can explore examples of BPE in action, as researchers explore the performance of a wide variety of built environments from individual workstations to entire campus and urban developments. This section may be of particular interest to design practitioners and building owners and managers working with similar typologies.

The case studies address changing meanings of office workspace, technology, flexibility, work styles, activities, communication and freedom of movement. One case study reports on a prototype housing evaluation that reveals three-fold differences in energy-efficiency in identical zero carbon homes. Outdoor university spaces are evaluated to assess their effect on learning and increased student-faculty interaction and heritage values are evaluated to identify.
Part IV – Research Methods and Tools

Performance evaluation involves the comparison between demand criteria and design outcomes. In Part IV authors provide a variety of approaches and techniques for evaluating the performance of built environments. With requirements analysis, performance criteria, data collection, occupant surveys, building representation, BPE practitioners, academics and students interested in undertaking their own investigation will find this section of particular interest.

In Chapter 14 Mallory-Hill and Westlund explore the measurement of the impacts of green building strategies on productivity, well-being and health of occupants in workplace environments. Preiser and Wang demonstrate how geographic information system and building performance evaluation methods are combined to provide a composite and weighted scoring system to evaluate a network of libraries. Schill-Fendl reports on a model with explicit laboratory design decisions. Finch et al. provide a method to evaluate designs, ability to increase daily exercise and therefore combat obesity. In Chapter 18, van der Voordt et al. identify critical building success factors for new workplace accommodation strategies.

The final two chapters in Part IV explore the role of computer simulation in building performance evaluation. In Chapter 19 Hensen discusses challenges of computational modeling of indoor environments that aims for ensuring occupant comfort and satisfaction. This is followed by Andrews et al., who introduce a simulation-modeling framework that highlights the occupants’ influence on building performance, and calibrates the model using post-occupancy evaluation (POE) survey data from a green commercial office building.

Part V – Education

The integration of evidence-based and service-based design into design school curricula is intended to help students provide more hands-on contact with real stakeholders and thereby gain a deeper understanding the issues of the design problems they must address. This section provides several examples of how students are involved in BPE processes.

In Chapter 21 Ornstein et al. highlight impact of POE on professional practice is discussed with reference to participatory design in social housing and subway stations. Next, Schramm provides his perspective of how to instruct students in the art of building performance evaluation and Salama reports on the implementation of a series of exercises that highlight the value of evaluation research as a form of experiential learning to invigorate the capabilities of future architects. Walden describes how students are involved in an investigation of how work performance, learning efficiency and well-being are affected by the degree of environmental control that workplaces afford employees. Finally, Pavlides and Cranz describe how ethnographic field research methods are used to assess how residents and other users experience
buildings and spaces and to teach semantic ethnography and photo-elicitation in social-cultural architecture courses.

**Part VI – Epilogue**

Frank Duffy reflects on development of building evaluation and argues that architecture needs evaluation now more than ever.
The editors would like to thank all the contributors to this volume for their excellent collaboration in bringing this project to fruition in a timely and professional manner.

We wish to start by recognizing the key facilitating role of the Environmental Design Research Association (EDRA) has had over the past 41 years in bringing together researchers to exchange ideas and advance knowledge in the discipline. Such collaborations have been many and outstanding results were the consequence. EDRA had a defining role in shaping the professional trajectories of many of its members, especially those who are represented in this book.

For example, Preiser’s master’s thesis at Virginia Tech focused on establishing quality profiles for different generations of dormitories (including those where the horrible shootings took place a few years ago), the results of which were presented at EDRA 1 in Raleigh, North Carolina. Consequently, research projects, consultations and teaching began to deal with Post-Occupancy Evaluation (POE), and later Building Performance Evaluation (BPE), the focus of this book. Along the way, these collaborations resulted in publications and, in many cases, long-lasting friendships. Preiser thanks his mentor, the late cyberneticist Heinz von Foerster, for initiating his interest in feedback, feed-forward and self-regulating control systems, which in turn, gave the impetus for decades of work in topics pertaining to evaluation. Preiser, who was a co-founder of Architectural Research Consultants in Albuquerque, New Mexico, in 1976, wishes to thank the firm for its continued interest and support in matters concerning building performance, master planning, programming and evaluation of projects.

Mallory-Hill, also a long-time EDRA-ite, is an educator and researcher in the areas of universal and sustainable workplace design and design-decision support systems. She wishes to thank her fellow members of the International Building Performance Evaluation (IBPE) research consortium for generously sharing their knowledge and expertise over the years. She is grateful for the ongoing support and encouragement she receives from the staff and students of the Department of Interior Design and the Faculty of Architecture at the University of Manitoba to undertake research and advance knowledge in the area of building performance evaluation.

Watson is a New Zealand architect who has evaluated most types of public buildings and many commercial buildings in order to improve future building programs. He appreciates the guidance and collegiality that Duncan Joiner has generously given over many years and on many projects. He also recognizes
the clients who have employed Post-Occupancy Evaluation as a way of understanding how other people experience buildings.

We thank Beth Edgar, Editorial Assistant at Wiley-Blackwell for her continuing guidance and support in this project.

Last, but not least, we thank our children and spouses/significant others for supporting this and many other efforts in the past and present.
If you want to know whether your building is any good or not, it would seem that the obvious thing to do would be to ask the people who use it.

This book is by people who are doing the obvious thing. They ask building users about the buildings they occupy, and use this information to guide the design of new buildings and modifications to existing buildings.

Why is this so remarkable? Asking the users might seem to be the obvious thing to do, but it is easier said than done. Who do you ask? What do you ask them? It takes thought and knowledge about building processes and the social contexts of building delivery, ownership and occupancy to develop ways of asking users for information. That is what the authors of this book have done. It is certainly not simple or straightforward, but this book will help building designers, owners and managers to find out how to do it.

Why is it important to find ways of asking users what they think of their buildings? Because the world is full of buildings which do not meet users' expectations. Most of us live and work in buildings which have unsuitable spaces, poor acoustical and air qualities, and a range of other inconveniences which we negotiate and put up with in our daily lives. If we have the opportunity to influence decisions about the kinds of spaces we use, the situation can become much better. In this book, there are outstanding examples of how involving users in building evaluation and design has achieved buildings which are appreciated by their users, and have even saved money for their owners.

While it might seem obvious and straightforward to ask building users about their buildings, there are a number of reasons why it doesn't happen as much as one might expect. Except for people who are able to engage an architect and builder to make their own house, there are few opportunities for communication between people who provide buildings and the people who use them. Most of the people who use commercial and public work places and facilities will never talk to the architects, engineers, and builders responsible for those buildings. Building users and providers are effectively two different cultures which rarely make contact, hold different values, and often conflict. Users and providers are alike in that they derive some advantage from their connection with the building, but are different in the nature of that advantage. To complicate matters further, building owners can be seen as a third culture. So while building designers will, for example, strive to optimize safety, site
coverage, cost, and a range of physical environmental constraints for an office
building, the owner will be measuring the success of the building in terms of
maximum tenant occupancy and rental return on capital outlay. None of
these things have much to do with the expectations of the building users’ for
a place to carry out their individual and collective work activities – in short, to
live their lives.

Ideally, the expectations of providers, owners and users would be balanced.
However, buildings usually satisfy one or the other group preferentially, and
often the interests of the providers and owners dominate, because these are
people who are accustomed to making decisions about what will be built in
their day-to-day work. They know how they want things to be, and they have
the resources to bring them about. Users rarely have that advantage, and so are
destined to accept things as they are. Without feedback from building users, it
is difficult for people who design buildings to know whether their design is as
good as it could be, or any good at all from the point of view of the users.

Without feedback from building users, providers use other factors to guide
and assess their work. There is an engineering dominance of hard data for
structure, air conditioning, power plant and machinery which is guided by
theoretical models and calculations, and which can be conclusively related to
costs. There are also building laws, standards and regulations for safety and
protection of public interest. But standards and regulations do not guarantee
comfort and safety, let alone user satisfaction. Because they are generic and
relate to all buildings in a jurisdiction, much of what they recommend will be
short on knowledge of what people think and do in buildings.

Many of the characteristics of a building which are appreciated by the users
are qualitative and subtle. They may have little to do with regulatory require-
ments for health and safety, and probably will have little to do with cost. There
is a complex relationship between the physical reality of buildings and spaces
and the expectations of all the people who use them, which could be clarified
by listening to the users.

There are characteristics of the building industry which support building
design and management systems based on contractual criteria which may not
have much to do with users’ expectations. In addition to this, conventional
forms of engagement of architects can distance them from users. Knowledge
about what works, what users like, and what is perhaps not so successful has
to be passed on from one project to another. This does not happen often, so
tradition, expedience and made up theory, form the basis for decision-making
in design.

Buildings are built to order, and as single complex entities, they include
hundreds of technical sub-systems and components from a variety of sources.
They may take months or even years to make, and when finished, users and
owners have to accept them as they are. The designers and providers of
buildings do not have the advantages of volume production industries where
large resources are devoted to prototyping and testing complete assemblies
before commitment is made to final production. There is nothing in the