

Smart Innovation, Systems and Technologies

Volume 34

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ICoRD'15 – Research into Design Across Boundaries Volume 1

Theory, Research Methodology, Aesthetics,
Human Factors and Education

 Springer

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ISSN 2190-3018 ISSN 2190-3026 (electronic)
Smart Innovation, Systems and Technologies
ISBN 978-81-322-2231-6 ISBN 978-81-322-2232-3 (eBook)
DOI 10.1007/978-81-322-2232-3

Library of Congress Control Number: 2014957705

Springer New Delhi Heidelberg New York Dordrecht London
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Printed on acid-free paper

Springer (India) Pvt. Ltd. is part of Springer Science+Business Media (www.springer.com)

Preface

Design is ubiquitous; it pervades all spheres of life, and has been around ever since life has been engaged in purposefully changing the world around it. While some designs have transcended time, designs are always in the process of being evolved. Research into design and the emergence of a research community in this area have been relatively new, its development influenced by the multiple facets of design (human, artefact, process, organisation, ecology, micro- and macro-economy by which design is shaped and which it shapes in turn) and the associated diversification of the community into those focusing on various aspects of these facets, in various applications. Design is complex, balancing the needs of multiple stakeholders, and requiring a multitude of areas of knowledge to be utilised, with resources spread across space and time.

The collection of papers in these two book volumes constitutes the Proceedings of the Fifth International Conference on Research into Design (ICoRD'15) held at the Indian Institute of Science, Bangalore, India during 7–9 January 2015. ICoRD'15 is the fifth in a series of biennial conferences held in India to bring together the international community from diverse areas of design practice, teaching and research. The goals are to share cutting edge research about design among its stakeholders; aid the ongoing process of developing a collective vision through emerging research challenges and questions; and provide a platform for interaction, collaboration and development of the community in order for it to address the global and local challenges by forming and realising the collective vision. The conference is intended for all stakeholders of design, and in particular for its practitioners, researchers, teachers and students.

Of the 265 abstracts submitted to ICoRD'15, 196 were selected for full paper submission. 151 full papers were submitted, which were reviewed by experts from the ICoRD'15 International Programme Committee comprising 180 members from over 131 institutions or organisations from 34 countries spanning six continents. Finally, 118 full papers, authored by over 275 (275 unique authors, actually 335 author entries in 118 papers) researchers from 86 institutions and organisations from 24 countries spanning six continents, were selected for presentation at the conference and for publication as chapters in this book. ICoRD has steadily

grown over the last four editions, from a humble beginning in 2006 with 30 papers and 60 participants, through 75 papers and 100 participants in ICoRD'09, 100 papers and 150 participants in ICoRD'11, to 114 papers and 170 participants in ICoRD'13.

ICoRD'15 had 14 sessions with 70 podium papers, and 48 papers with brief podium presentations followed by poster display and discussion. It had keynotes from prominent researchers and practitioners from around the world such as: Vincent Floderer from CRIMP, France, Kristin Wood from Singapore University of Technology and Design, Singapore, John Gero from George Mason University, USA, Richard Gardner from The Boeing Company, USA, Sudhakar Nadkarni from Welingkar Institute of Management, India, and Rishikesh Krishna from Indian Institute of Management Indore, India. It had two panel discussions on “Publishing Research Papers” and “Practice of Design”, and five workshops, on Design Cognition, Sustainability, Emotional Engineering, Paper Crumpling, and Design Innovation Centre (DIC) Hubs in India. From 2015, ICoRD started giving **ICON**³ awards (acronym for **ICoRD Outstanding Contribution to design science and education**) to outstanding contributors to design education and research. Professor Sudhakar Nadkarni and Prof. John Gero were selected as **ICON**³ awardees for 2015, respectively for their outstanding contributions to design education and design research.

The chapters in this book together cover all three major areas of products and processes: functionality, form and human factors. The spectrum of topics range from those focusing on early stages such as creativity and synthesis, through those that are primarily considered in specific stages of the product life cycle, such as safety, reliability or manufacturability, to those that are relevant across the whole product life cycle, such as collaboration, communication, design management, knowledge management, cost, environment and product life cycle management. Issues of delivery of research into design, in terms of its two major arms: design education and practice, are both highlighted in the chapters in this book. Foundational topics such as the nature of design theory and research methodology are also major areas of focus. It is particularly encouraging to see in the chapters the variety of areas of application of research into design— aerospace, healthcare, automotive and white goods are but a few of the sectors explored. The theme of this year's conference and of this book is “Design Across Boundaries”, where boundaries are manifold and span many dimensions—economy, culture, age, gender, religion, caste, class, education, family, digitalisation, geography (rural/urban) and so on.

The book has two volumes. Volume I focuses on Design Theory, Research Methodology, Aesthetics, Human Factors and Education. Volume II focuses on Design Creativity, Sustainability, Design for X, Enabling Technologies, Design Management and Applications in Practice. Volume I broadly focuses on form and human factors, while Volume II focuses on functionality.

On behalf of the Steering Committee, Advisory Committee, Local Organising Committee and Co-Chairs, I thank all the authors, delegates, institutions and organisations that participated in the conference and the International Programme Committee for their support in organising ICoRD'15 and putting this book together. I am thankful to the Design Society and Design Research Society for

their kind endorsement of ICoRD'15. I thank Indian Institute of Science (IISc), Bangalore and its Centre for Product Design and Manufacturing, for their support of this event. I also wish to place on record and acknowledge the enormous support provided by Mr. Ranjan B.S.C., Ms. Kumari M.C. and Ms. Nishath Salma of IISc in managing the review process, and in preparation of the conference programme and this book, and the large and dedicated group of student-volunteers of Indian Institute of Science, Bangalore in the organisation of the conference. Finally, I thank Springer, especially its Editor Ms. Swati Meherishi, for the wonderful support extended in the publication of this book and for sponsoring books and book coupons for Distinguished Paper Awards and **ICON**³ Awards respectively.

Amaresh Chakrabarti

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About the Conference

Design is ubiquitous; it pervades almost all spheres of life, and has been around as long as life has taken up the task of purposefully changing the world around it. Research in design and the emergence of a research community in this area has been relatively new, its development influenced by the multiple facets of design (human, artefact, process, organization, and the micro- and macro economy by which design is shaped) and the associated diversification of the community into those focusing on various aspects of these individual facets, or various applications. Design is complex, balancing the needs from multiple stakeholders, and requiring a multitude of areas of knowledge to be utilized, from resources spread across space and time.

ICoRD'15 is the fifth in a series of conferences intended to be held every 2 years in India to bring together the international community from diverse areas of design practice, teaching and research, to: showcase cutting edge research about design to the stakeholders; aid the ongoing process of developing and extending the collective vision through emerging research challenges and questions; and provide a platform for interaction, collaboration and development of the community in order for it to take up the challenges to realize the vision. The conference is intended for all stakeholders of design, and in particular for its practitioners, researchers, teachers and students.

The theme of ICoRD'15 is "Design Across Boundaries." Human society is ridden with boundaries: economic, political, religious, educational, cultural, racial, caste and class-based, age-based, ability-based, environmental, oriental-occidental, rural–urban, traditional–modern and so on. Yet designs must transcend boundaries to create value for people from all walks of the global society. Specific forms of design across boundaries are already being encapsulated in for instance "inclusive design" which aims to help melt age- and ability-based boundaries, or "design for the bottom-of-the-pyramid" which extends design to those with extreme economic challenges. The theme of ICoRD'15 is a celebration of the power of design to be pervasive. It is also a call to the design and its research fraternity to acknowledge boundaries, if only to transcend them and reach the benefits of design to everyone.

The conference has:

- Invited presentations from eminent international experts and practitioners;
- Presentations of refereed papers as podium, poster, panel or theme presentations;
- Industrial sessions to present perspectives from industry and studies in practice.

ICoRD' 15 is co-located with the 3rd International Conference on Design Creativity (3rd ICDC) held in Bangalore, India, 12–14 January, 2015.

About the Editor

Amaresh Chakrabarti is professor of Engineering Design at Centre for Product Design and Manufacturing, Indian Institute of Science (IISc), Bangalore. He holds a BE in Mechanical Engineering from University of Calcutta (now IIST), India, an ME in Mechanical Design from IISc, and a Ph.D. in Engineering Design from University of Cambridge, UK. After Ph.D., he led for 10 years the Design Synthesis team at the EPSRC Centre for Excellence Engineering Design Centre at University of Cambridge. His interests are in design synthesis and creativity, eco-design and sustainability, and product informatics. He has authored/edited 10 books, over 250 peer-reviewed articles, and has six patents granted/pending. He co-authored DRM, a methodology used widely as a framework for doing engineering design research. He is an Associate Editor, AI EDAM, Area Editor, Research in Engineering Design (Springer), Regional Editor, Journal for Remanufacturing (Springer), and Advisory Editor for seven international journals including Journal of Engineering Design, Clean Technologies and Environmental Policy (Springer), and International Journal of Design Creativity and Innovation. Professor Chakrabarti has been on the Advisory Board of Design Society, UK, where he is currently a member of the Board of Management. He is a member of the CII National Committee on Design, India, and member of the Jury for India Design Mark, India Design Council. He founded IDEaSLab—the first laboratory in India for research into design creativity, sustainability and innovation. He is Chair for International Conferences on Research into Design (ICoRD), 22nd CIRP Design Conference (CIRP Design 2012), 3rd International Conference on Design Creativity (3rd ICDC 2015), and vice-Chair for AI in Design (AID) and Design Computing and Cognition (DCC) Conferences. He is an Honorary Fellow of the Institution of Engineering Designers, the peer society under the UK Royal Charter in engineering design. Seven of his papers won top paper awards in various international conferences.