

Lecture Notes in Mechanical Engineering

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Prasad S. Onkar
Mohammad Shahid *Editors*

Responsible and Resilient Design for Society, Volume 9

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Lecture Notes in Mechanical Engineering

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Preface

The collection of papers in these twelve book volumes constitutes the Proceedings of the Tenth International Conference on Research into Design (ICoRD'25) held at the Indian Institute of Technology Hyderabad, India, during 8–10 January 2025. ICoRD'25 is the tenth 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.

About 1228 abstracts were submitted to ICoRD'25, from which 1184 were accepted for full paper submission. A total of 699 full papers were submitted, which were reviewed by experts from the ICoRD'25 International Programme Committee comprising 319 members from over 214 institutions or organisations from 44 countries spanning five continents. Finally, 486 full papers that were authored by 1333 researchers (981 unique authors, actually 1333 author entries in 486 papers) from 16 countries spanning 5 continents were selected for presentation at the conference and for publication as chapters in this book. ICoRD has steadily grown over the last eight 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, 114 papers and 170 participants in ICoRD'13, 118 papers and 200 participants in ICoRD'15, 177 papers and 230 participants in ICoRD'17, 169 papers and 352 participants in ICoRD'19, 235 papers and 271 participants in ICoRD'21 (online), and 300 papers and 420 participants in ICoRD'23.

ICoRD'25 had 486 podium papers. It had six keynotes from prominent researchers and practitioners from around the world, such as Professor Pascal Le Masson from Mines Paris—PSL Research University, France; Professor Sophie Isaksson Hallstedt

from Chalmers University of Technology, Sweden; Dr. Arun Jaura from SAE International and former CTO Hero Motorcorp; Professor Janet K. Allen from University of Oklahoma, USA; Professor Puneet Tandon from Indian Institute of Information Technology, Design and Manufacturing, Jabalpur, India; and Professor Amarendra Kumar Das from the Indian Institute of Technology Guwahati, India. It had two panel discussions on ‘Panel Discussion on Design Education’ and ‘Panel Discussion on Publishing Design Research’, 22 workshops which included Ph.D. Students Symposium and Publishing Workshop and a networking event ‘Young Researchers’ Meet’.

Since 2015, ICoRD has initiated ICONNN Awards (acronym for ICoRD Outstanding Contribution to design science and education) to be given to two outstanding contributors to design education and research at each ICoRD. Professor Sudhakar Nadkarni from Welingkar Institute of Management, India, and Professor John Gero from George Mason University, USA, were selected as the ICONNN awardees for 2015. Professors Amit Ray from Shiv Nadar University, India, and Cees de Bont from Hong Kong Polytechnic University, Hong Kong, had been selected as the ICONNN awardees for 2017. For ICoRD’19, the ICONNN awardees are Professor Imre Horvath from Delft University of Technology, the Netherlands, and Professor T. S. Mruthyunjaya from Indian Institute of Science, Bengaluru, India. For ICoRD’23, the ICONNN awardees are Professor Uday Athavankar from MIT School of Design, Pune, India, and Professor Farrokh Mistree from University of Oklahoma, USA. For ICoRD’25, the ICONNN awardees are Professor B. Gurumoorthy, Indian Institute of Science, India, and Professor Peter Childs, Imperial College, London, UK.

The chapters in the 12 book volumes together cover all three major areas of products and processes: functionality, form, and human factors. The spectrum of topics ranges from those focusing on early stages, such as creativity and synthesis, through those that are primarily considered in later 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 of the book volumes. 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, health care, automotive, biomedical, and so on.

The theme of ICoRD’25 is ‘Responsible and Resilient Design for Society’. The contemporary world is in the midst of significant shifts, encompassing everything from climate change to the rapid advancements in artificial intelligence. These transformations impact the fabric of everyday human lives and society as a whole. In this context, design emerges as a crucial player, offering a pivotal role in navigating these changes to foster a balanced and just world. This conference edition places a

spotlight on the theme of ‘Responsible and Resilient Design for Society.’ Here, the design research community underscores the importance of adopting approaches that contribute to building a resilient society while acknowledging the responsibilities that come with being designers and researchers.

On behalf of the Steering Committee, Advisory Committee, Organising Committees, and Co-chairs, we thank all the authors, delegates, institutions, and organisations that participated in the conference. We also thank the members of the International Programme Committee for their support in reviewing the papers for ICoRD’25, which is essential for maintaining the quality of the conference, and for their support in putting this book together.

We are thankful to the Design Society and Design Research Society for their kind endorsement of ICoRD’25. We thank the Indian Institute of Technology (IIT) Hyderabad and its Department of Design, and the Indian Institute of Science (IISc) Bengaluru and its Department of Design and Manufacturing (formerly Centre for Product Design and Manufacturing (CPDM)) for their support of this event. We also wish to place on record and acknowledge the enormous support provided by the Local Organising Committee in managing the review process, in preparation of the conference programme and this book and the conference as a whole. In particular, we wish to thank Ms. Mary Ranjeetha and Mr. Sumit Yempalle for their valuable contributions during the preparatory stages of ICoRD’25. We also thank the large and dedicated group of student and staff volunteers of IIT Hyderabad and IISc Bengaluru for the organisation of the conference. We also thank the sponsors, Suzuki Innovation Centre and Oil India Limited, for their generous support for the conference. Finally, we thank Springer Nature, especially its Editor Ms. Swati Meherishi and her editorial support team, for their wonderful support, including their sponsoring of the Springer book vouchers for the ICONNN awardees and the winners of Distinguished Paper Awards at ICoRD’25.

Bengaluru, India
Bengaluru, India
Hyderabad, India
Hyderabad, India

Amaresh Chakrabarti
Vishal Singh
Prasad S. Onkar
Mohammad Shahid

About the Conference

Design is ubiquitous; it pervades 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 into design and the emergence of a research community in this area have been relatively new. Its development has been influenced by the multiple facets of design (human, artefact, process, organisation, the micro- and macro-economy, and the ecology by which design is shaped) and the associated diversification of the community depending on the facets of focus or that of their 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. ICoRD'25 is the tenth in a series of conferences intended to be held every two years in India, to bring together the international community from diverse areas of design practice, education, and research. It aims 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 realise the vision. The conference is intended for all stakeholders of design and, in particular, for its practitioners, researchers, pupils, and educators.

The collection of papers in these twelve book volumes constitutes the Proceedings of the Tenth International Conference on Research into Design (ICoRD'25) held at the Indian Institute of Technology Hyderabad, India, during 8–10 January 2025. ICoRD series was initiated in 2006 by the Department of Design and Manufacturing—DM (formerly Centre for Product Design and Manufacturing (CPDM)) at the Indian Institute of Science (IISc), Bengaluru. Since then, it has been hosted in 2009, 2011 (both at IISc), 2013 (at IIT Madras), 2015 (IISc), 2017 (IIT Guwahati), 2019 (IISc), 2021 (IIT Bombay), and 2023 (IISc). DM has pioneered design research in India for the last two decades. IISc is one of India's leading science and technology institutions and is one of the Institutes of Eminence decreed by the MoE, Government of India. ICoRD'25 was hosted by IIT Hyderabad in its vast premise, showcasing the newest face of India's higher education ecosystem. IITH

was founded in 2008 and is one of the fastest growing institutes of higher education in India. It has been ranked consistently among the best academic institutions in India, with every institute ranked above it being at least 14 years older than it. The theme of ICoRD'25 is 'Responsible and Resilient Design for Society'. The contemporary world is in the midst of significant shifts, encompassing everything from climate change to the rapid advancements in artificial intelligence. These transformations impact the fabric of everyday human lives and society as a whole. In this context, design emerges as a crucial player, offering a pivotal role in navigating these changes to foster a balanced and just world. This conference edition places a spotlight on the theme of 'Responsible and Resilient Design for Society.' Here, the design research community underscores the importance of adopting approaches that contribute to building a resilient society while acknowledging the responsibilities that come with being designers and researchers.

The conference contained:

- Invited/keynote presentations from eminent international experts and practitioners.
- Presentations of refereed papers as podium, poster, panel, or theme presentations.
- Industrial session to present perspectives from industry and studies in practice.
- Presentation of ICONNN Awards and Keynotes.
- Doctoral symposium.
- Networking sessions for young researchers.
- Workshop sessions.

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logo, which is widely recognized across educational institutions in India. He has also been recognized with several awards, including Best Typography Poster Design at Typography Day 2017, 2021 & 2023, Teaching Excellence Award 2022 at IIT Hyderabad, and Best Paper Award at the International Conference on Creativity and Cognition in Art and Design 2017. His teaching interests include graphic design, type design and visual branding, among others.