



Proceedings of the
NordDesign 2020 conference

August 11 – 14, 2020

Technical University of Denmark (DTU)

Edited by:

Niels Henrik Mortensen

Claus Thorp Hansen

Michael Deininger



Section of Engineering Design and Product Development
Department of Mechanical Engineering
Technical University of Denmark (DTU)

Published by



Registered Charity Number: SC031694

Registered Company Number: SC401016

www.designsociety.org

Design Society publication number: DS 101

ISBN number: 978-1-912254-08-8

Copyright © 2020 The Design Society

Preface

NordDesign 2020, the 13th biennial NordDesign conference, took place from August 11-14, 2020. This year's conference, "Balancing Innovation and Operation," was organized by the Section of Engineering Design and Product Development in the Department of Mechanical Engineering at the Technical University of Denmark (DTU). Following the previous NordDesign conferences in Helsinki (1996), Stockholm (1998), Copenhagen (2000), Trondheim (2002), Tampere (2004), Reykjavik (2006), Tallinn (2008), Gothenburg (2010), Aalborg (2012), Helsinki (2014), Trondheim (2016) and Linköping (2018), 2020 marked the second time that the conference came to Copenhagen. Due to the Covid-19 pandemic, the organizing committee decided that the conference would be offered online only.

The NordDesign conference series aims to serve as a Nordic complement to the large European and American Design Society conferences within the fields of Engineering and Product Design, and also welcomes participants from other countries. Oversight by the Nordic Scientific Advisory Committee, consisting of representatives from the main technological universities in the Nordic region, ensures the quality and continuity of the conference series.

2020 conference theme: Balancing Innovation and Operation

Industrial companies today must launch increasingly innovative products and services faster than ever, while simultaneously increasing operational efficiency. On the innovation side, key questions relate to true user experience, circularity, and implementation of electrification and digitalization of products, as examples. Concerning operations efficiency, key questions relate to automation, modularization and manufacturing footprint, among many others. The way product and service development is executed very much influences both innovation and operational efficiency, and this is the overall theme that was explored from numerous perspectives during NordDesign 2020.

2020 NordDesign conference sessions

This year's conference theme called for evidence-based academic work on topical issues on design, product development and innovation to strengthen both our theoretical understanding and the connection between theory and practice.

Upon the call for submissions, the organizing committee received 76 full paper drafts. After a double-blind review process, 70 papers were invited for revised submission, and a final 61 papers, representing 12 countries, have been accepted and are included in these proceedings.

The organizing committee categorized and organized the papers into sessions that reflect the following themes: Circularity & Sustainability; Prototyping; Modularity; New Technology; Robust Products and Processes; Teaching and Education; Collaborative Design; Design Studies; Big Data, Early-Stage Design; Design Support; and Requirements Management.

Acknowledgements

The organizing committee would like to thank all colleagues and students who have contributed to making NordDesign 2020 possible. We are also thankful to all 56 reviewers who have generously contributed their time to scientific reviews.

NordDesign 2020 Organizing Committee

Niels Henrik Mortensen, Conference chair

Claus Thorp Hansen, Program chair

Michael Deininger, Head of organization

Lis Paludan, Secretary

Sofie Bejder, Student assistant

Nordic Scientific Advisory Committee

Niels Henrik Mortensen, Dept. of Mechanical Engineering, DTU, Kgs. Lyngby, Denmark

Claus Thorp Hansen, Dept. of Mechanical Engineering, DTU, Kgs. Lyngby, Denmark

Poul Kyvsgaard Hansen, Center for Industrial Production, AAU, Aalborg, Denmark

Martin Steinert, Dept. of Engineering Design and Materials; NTNU, Trondheim, Norway

Johannes Sigurjonsson, Dept. of Product Design Engineering, NTNU, Trondheim, Norway

Tero Juuti, Dept. of Mech. Engineering and Industrial Systems, TUT, Tampere, Finland

Kalevi Ekman, Dept. of Engineering Design and Production, AU, Helsinki, Finland

Johan Malmqvist, Division of Product and Production Development, CTH, Göteborg, Sweden

Sofia Ritzén, Dept. of Machine Design, KTH, Stockholm, Sweden.

Rögnvaldur Jóhann Sæmundsson, Faculty of Industrial Engineering, University of Iceland, Reykjavik, Iceland

Tauno Otto, Fac. of Mechanical Engineering, TTÜ, Tallinn, Estonia

List of reviewers

Albert Albers, Karlsruhe Institute of Technology

Alessandro Bertoni, Blekinge Institute of Technology

Anna Olsen, Norwegian University of Science and Technology

Bhagyashri Sharma, Pearl Academy

Camilla Arndt Hansen, Technical University of Denmark
Casper Boks, Norwegian University of Science and Technology
Christian Alexander Bertram, Technical University of Denmark
Christian Johansson, Blekinge Institute of Technology
Christoffer Askhøj, Technical University of Denmark
Claus Thorp Hansen, Technical University of Denmark
Dieter Krause, TU Hamburg
Evangelos Tyflopoulos, Norwegian University of Science and Technology
Felix Laufer, University of Stuttgart
Georg Otto Müller, Technical University of Denmark
Hatice Merve Demirci, Atilim University
Heikki Sjöman, Norwegian University of Science and Technology
Henrikke Dybvik, Norwegian University of Science and Technology
Iñigo Alonso Fernandez, Chalmers University of Technology
Jakob Trauer, Technische Universität München
Jan Behrenbeck, Technische Universität München
Jarkko Tapani Pakkanen, Tampere University
Jeffrey Lynn Hartley, University of Michigan
Johan Malmqvist, Chalmers University of Technology
Johan Wall, Blekinge Institute of Technology
Jóhannes B. Sigurjónsson, Norwegian University of Science and Technology
Jonas Heimicke, Karlsruhe Institute of Technology
Josephine Tamsin Steed, The Robert Gordon University
Joshua Fahl, Karlsruhe Institute of Technology
Kristin Paetzold, Universität der Bundeswehr München
Lars Almefelt, Chalmers University of Technology
Marco Bertoni, Blekinge Institute of Technology
Maria Siiskonen, Chalmers University of Technology
Mariia Kravchenko, Technical University of Denmark
Markus Zimmermann, Technical University Munich
Martin Steinert, Norwegian University of Science and Technology
Massimo Panarotto, Chalmers University of Technology
Michael Deininger, Technical University of Denmark

Nicklas Werge Svendsen, Technical University of Denmark
Niels Henrik Mortensen, Technical University of Denmark
Niti Bhan, Aalto University
Nuno Miguel Martins Pacheco, Technical University Munich
Ola Isaksson, Chalmers University of Technology
Olivia Borgue, Chalmers University of Technology
Pasi Aalto, Norwegian University of Science and Technology
Pieter Vermaas, Delft University of Technology
Prasad Onkar, Indian Institute of Technology Hyderrabad
Roger Johansson, Dalarna University
Ryan Michael Arlitt, Technical University of Denmark
Santosh Jagtap, Blekinge Institute of Technology
Stanko Skec, University of Zagreb
Taylor Stone, Delft University of Technology
Tero Juuti, Tampere University
Thomas Vietor, TU Braunschweig
Timo Lehtonen, Tampere University
Tobias Huth, TU Braunschweig
Torben Anker Lenau, Technical University of Denmark