Johan Malmqvist, Jens Bennedsen,
Kristina Edström, Natha Kuptasthien,
Angkee Sripakagorn, Janne Roslöf,
Ingunn Saemundsdottir
& Maria Siiskonen (eds.)

The 16ᵗʰ International CDIO Conference

**Proceedings – Full Papers
Volume 1(2)**

Johan Malmqvist, Jens Bennedsen, Kristina Edström, Natha Kuptasthien, Angkee Sripakagorn Janne Roslöf, Ingunn Saemundsdottir & Maria Siiskonen (eds.)
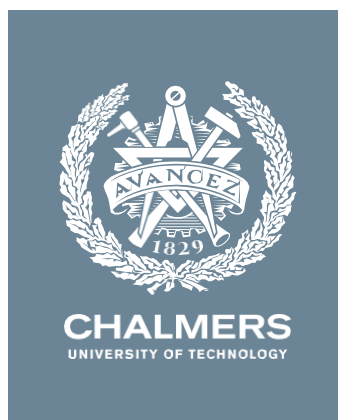
The 16th International CDIO Conference

Proceedings – Full Papers
Volume 1(2)

Editorial

The CDIO approach is an innovative educational framework for producing the next generation of engineers. The aim is an education that supports students in acquiring deep working understanding of technical fundamentals while simultaneously developing the necessary professional skills required of a practising engineer. This is done by providing students with dual-impact learning experiences that are based upon the lifecycle of an engineering project, the Conceiving – Designing – Implementing – Operating (CDIO) of real-world products, processes, and systems. Throughout the world, more than 180 institutions have adopted CDIO as the framework of their curriculum development.

The Annual International Conference is the central meeting of the CDIO Initiative, and it includes presentations of papers as well as specialised seminars, workshops, roundtables, events and activities. The 16th International CDIO Conference was planned to take place in Bangkok, Thailand, on June 8-12, 2020, hosted by Chulalongkorn University and Rajamangala University of Technology Thanyaburi. However, the travel restrictions due to the COVID-19 pandemic necessitated a change of format from a physical to an online conference. The online conference was hosted by Chalmers University of Technology, Sweden, June 8-10, 2020.

The theme of this year was Sustaining Change. The theme is visible in the keynote presentations and paper presentations. A roundtable session was focused on the changes to engineering education pedagogy driven by the move towards online learning technology that was radically accelerated by the pandemic. The rich topical program facilitated lively discussions and contributed to the further advancement of engineering education.

The conference included three types of contributions: Full Papers, Project in Progress contributions and Roundtables. The Full Papers fell into three tracks: Advances in CDIO, CDIO Implementation, and Engineering Education Research. All contributions have undergone a full single-blind peer-review process to meet scholarly standards. The Projects in Progress contributions describe current activities and initial developments that have not yet reached completion at the time of writing.

Initially, 208 abstracts were submitted to the conference. The authors of the accepted Full Paper and Projects in Progress abstracts submitted 134 manuscripts to the peer-review process. During the review, 429 review reports were filed by 116 members of the 2020 International Program Committee. Acceptance decisions were made based on these reviews. The reviewers' constructive remarks served as valuable support to the authors of the accepted papers when they prepared the final versions of their contributions. We want to address our warmest thanks to those who participated in the rigorous review process. Due to the rapid change of the conference format, most of the Project in Progress contributions were encouraged to withdraw and resubmit to a future conference.

This publication contains the 64 accepted Full Paper contributions that were presented at the conference, of which 8 are Advances in CDIO, 46 are CDIO Implementation, and 10 are Engineering Education Research. These papers have been written by around 190 different authors representing 23 countries. In addition to the Full Papers,

6 Projects in Progress contributions were presented at the conference and are not included in this publication. Two working groups worked prior to and during the conference. We hope you find these contributions valuable for your own research, curriculum development, and teaching practice, ultimately furthering the engineering profession. We also hope that you benefit through the truly unique community of practice that exists within the CDIO Initiative. The participants present at the conference seized the opportunity to discuss and share with colleagues, as global awareness and partnerships are of significant importance in the education of the next generation of engineers.

Gothenburg, 10 September 2020

Johan Malmqvist
Jens Bennedsen
Kristina Edström
Natha Kuptasthien
Angkee Sripakagorn
Janne Roslöf
Ingunn Saemundsdottir
Maria Siiskonen

Conference Organization

Organising Committee

Conference Chair
Johan Malmqvist
Chalmers University of Technology, Sweden

General Secretary
Maria Siiskonen
Chalmers University of Technology, Sweden

CDIO 2019 contact
Jens Bennedsen
Aarhus University, Denmark

CDIO 2021 contact
Natha Kuptasthien
Rajamangala University of Technology Thanyaburi, Thailand

International Program Committee Chair
Janne Roslöf
Turku University of Applied Sciences, Finland

International Program Committee

Chair
Janne Roslöf
Turku University of Applied Sciences, Finland

Co-Chairs
Jens Bennedsen
Aarhus University, Denmark

Kristina Edström
KTH Royal Institute of Technology, Sweden

Natha Kuptasthien
Rajamangala University of Technology Thanyaburi, Thailand

Ingunn Sæmundsdóttir
Reykjavik University, Iceland

Angkee Sripakagorn
Chulalongkorn University, Thailand

Members

Mohamad Farhat
Australian College of Kuwait

Natha Kuptasthien
Rajamangala University of Technology
Thanyaburi

Ron Hugo
University of Calgary

Anna-Karin Högfeldt
KTH Royal Institute of Technology

Juha Kontio
Turku University of Applied Sciences

Johan Malmqvist
Chalmers University of Technology

Matt Murphy
University of Liverpool

Siegfried Rouvrais
IMT Atlantique, Telecom Bretagne

Gareth Thomson
Aston University

Jens Bennedsen
Aarhus University

Bao Le N.
Duy Tan University

Hrafn Loftsson
Reykjavík University

Piety Runhaar
Wageningen University

Kim Fai Soh
Singapore Polytechnic

Thirawat Mueansichai
Rajamangala University of Technology
Thanyaburi

Nancy Nelson
University of Calgary

María Óskarsdóttir
Reykjavík University

Claudio Oyarzo
Universidad Católica de la Santísima
Concepción

Robyn Paul
University of Calgary

Frank Pettersson
Åbo Akademi University

Patricio Poblete
Universidad de Chile

Suree Pumrin
Chulalongkorn University

Stephanie Reynolds
Hokuriku University

Remon Rooij
TU Delft

Ingunn Sæmundsdóttir
Reykjavik University

Gudrún Arnbjorg Saevarsdottir
Reykjavík University

Achyut Sapkota
National Institute of Technology,
Kisarazu College

Pacharathon Simking
Rajamangala University of Technology
Thanyaburi

Hlynur Stefansson
Reykjavík University

Kittipong Suweero
Rajamangala University of Technology Thanyaburi

Halldór Guðfinnur Svavarsson
Reykjavík University

Valentina Tassone
Wageningen University

Hannes Vilhjalmsson
Reykjavík University

Abdulkareem Sh. Mahdi Al-Obaidi
Taylor's University

Hallgrimur Arnalds
Reykjavik University

Eyjolfur Ingi Asgeirsson
Reykjavík University

Haraldur Audunsson
Reykjavík University

John David Baird
Reykjavík University

Pauline Baird
International College of Technology

Jerker Björkqvist
Åbo Akademi University

Ramon Bragos
Telecom-BCN, Universitat Politècnica de Catalunya

Bob Brennan
University of Calgary

Watanachai Smittakorn
Chulalongkorn University

Jónas Þór Snæbjörnsson
Reykjavík University

Robert Songer
Kanazawa International College of Technology

Rungnapa Sranujit
Rajamangala University of Technology Thanyaburi

Asa Bjork Stefánsdóttir
Reykjavík University

Shoji Takechi
Kanazawa Institute of Technology

Uravis Tangkijviwat
Rajamangala University of Technology Thanyaburi

Nikorn Teptong
Rajamangala University of Technology Thanyaburi

Eythór Rafn Thorhallsson
Reykjavík University

Sanidda Tiewtoy
Rajamangala University of Technology Thanyaburi

Agust Valfells
Reykjavík University

Seppo Virtanen
University of Turku

Tomohito Yamamoto
Kanazawa Institute of Technology

Kristina Edström
KTH Royal Institute of Technology

Ratchatin Chancharoen
Chulalongkorn university

Hans Peter Christensen
DTU Technical University of Denmark

Alexander Chuchalin
Kuban State Technological University

Marjan Eggermont
University of Calgary

Sigurdur Ingi Erlingsson
Reykjavík University

Jane Flarup
Institute of Business and Technology,
Aarhus University

Joseph Timothy Foley
Reykjavík University

Clement Fortin
Skoltech

Hera Grimsdottir
Reykjavík University

Maria Sigridur Gudjonsdottir
Reykjavík University

Svante Gunnarsson
Linköping University

Åsa Gustafsson
Linneaus University

Stephanie Hladik
University of Calgary

Naebboon Hoonchareon
Chulalongkorn University

Aldis Ingimarsdottir
Reykjavík University

Nicholas Bertozzi
Worcester Polytechnic Institute

Geza Fischl
Jönköping University

Samuel Azasu
University of the Witwatersrand

Jonte Bernhard
Linköping University

Suzanne Brink
Leiden University

Perry den Brok
Wageningen University and Research

Sin Moh Cheah
Singapore Polytechnic

Mikael Enelund
Chalmers University of Technology

Fredrik Georgsson
Umeå University

Lars Geschwind
KTH Royal Institute of Technology

Alejandra Gonzalez
Pontificia Universidad Javeriana

Peter Goodhew
NMiTE

Peter Gray
United States Naval Academy

Paul Hermon
Queen's University Belfast

Sarah Junaid
Aston University

Anna Sigridur Islind
Reykjavík University

Pall Jensson
Reykjavík University

Rossarin Jermtaisong
Rajamangala University of Technology Thanyaburi

Rapee Kanchana
Rajamangala University of Technology Thanyaburi

Sorada Kanokpanont
Chemical Engineering, CU

Mirka Kans
Linnaeus University

Leif Kari
KTH Royal Institute of Technology

Parichart Kleunsuwan
Rajamangala University of Technology Thanyaburi

Ragnar Kristjansson
Reykjavík University

Samuel Brüning Larsen
DTU Technical University of Denmark

Aage Birkkjær Lauritsen
Aarhus University

Andrei Manolescu
School of Technology

Blake Matheny
Kanazawa Institute of Technology

Asrun Matthiasdottir
Reykjavík University

Olivier Moschetta
Reykjavík University

Elizabeth Keller
KTH Royal Institute of Technology

Helene Leong
Singapore Polytechnic

Reidar Lyng
NTNU Norwegian University of Science & Technology

Nicoleta Maynard
Monash University

Charlie McCartan
Queen's University Belfast

Marcia Muñoz
Universidad Católica de la Santísima Concepción

Declan Phillips
University of Limerick

Anders Rosén
KTH Royal Institute of Technology

Rick Sellens
Queen's University at Kingston

Vesa Taatila
Turku University of Applied Sciences

David Tanner
University of Limerick

Mette Lindahl Thomassen
VIA Engineering, VIA UC & Aarhus University

Emiel van Puffelen
Wageningen University and Research

Janne Roslöf
Turku University of Applied Sciences

Angkee Sripakagorn
Chulalongkorn University