ECC 2024 Tutorial

“Automatic Control Horizon: Roadmap and Industrial Innovation”

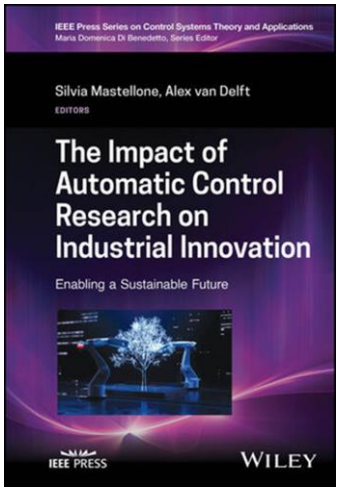
Summary and Agenda

Silvia Mastellone, Alisa Rupenyan, Tariq Samad, Pieder Jörg, Efe Balta, Alex van Delft

***Abstract*— This document introduces the context and the roadmap for a tutorial session with the focus on closing the gap between academic research and industrial practice in automatic control.**

I. Introduction

Within the context of the IFAC Industry Committee mission, recently in 2023 an edited volume (“The Impact of Automatic Control Research on Industrial Innovation: Enabling a Sustainable Future”) was published as part of the book series on “Control Systems: Theory and Applications” of IEEE Press, an imprint of John Wiley & Sons [1].



Prof. Dr. Silvia Mastellone is with the University of Applied Science Northwest Switzerland.

Prof. Dr. Alisa Rupenyan is with ZHAW, Switzerland.

Pieder Jörg MSc is with ABB, Switzerland.

Dr. Tariq Samad is with the University of Minnesota, USA.

Dr. Efe Balta is with Inspire, Zurich, Switzerland.

Dr. Alex van Delft was Corporate Manager Process Control, Royal DSM, The Netherlands until end of 2020 and now acts as independent consultant.

All are Members of the IFAC Industry Committee.

The book consists of separate chapters on process industry, robotics and manufacturing automation, data industry, energy and power conversion, building automation and automotive. The book is based on an earlier paper in “Control Engineering Practice” [2], which was co-authored by Prof. Dr. Silvia Mastellone and Dr. Ir. Alex van Delft, who are also the editors of the edited volume.

In this book a framework is proposed to close the gap between fundamental control research and practice towards catalyzing technology innovation. Key elements of the framework: systems and process thinking, vision driven innovation, systematic identification of customer require-ments, addressing profitability and implementation aspects. The book highlights key drivers for innovation, limitations encountered in practice, and suggested research directions. The topic of the gap between academia and industrial practice is also highlighted in many other publications, e.g., in [3] and [4].

Also, in 2023, the IEEE Control for Societal-Scale Challenges: Roadmap 2030 was published, with an emphasis on academic research topics for different industrial and societal challenges [5].

Fig 1: Control Research and Industrial Innovation (from [1]).

II. Objectives and Agenda for the Tutorial

A. Session objectives

Based on the Edited Volume and the Roadmap, the authors see the concept of a tutorial as an excellent opportunity to:

1. Create insights and engagement among conference participants about the urgency to close the gap between academia and industry.
2. Obtain feedback on the ideas and concepts presented.
3. Generate insights on the research demands per industry sectors: what are characteristic generic issues for research and in what way are the sectors different in their demands?

B. Agenda

To achieve these objectives, we propose the following general agenda:

Topic	Time	Lead Facilitator(s)
General Introduction of the session and the Volume: Innovation framework	15’	Prof. Silvia Mastellone
Case Study: Robotics and Manufacturing Automation	20’	Prof. Alisa Rupenyan, Dr. Efe Balta
Case Study: Energy & Power Conversion	20’	Pieder Jörg MSc
Introduction of Control for Societal-Scale Challenges: Roadmap 2030	20’	Dr. Tariq Samad
Interactive Wrap up	45’	Prof. Silvia Mastellone Dr. Tariq Samad Prof. Alisa Rupenyan Pieder Jörg MSc Dr. Efe Balta

C. Detailed schedule

Below you can find the detailed time schedule for the planned 2-hour time slot. We have included ways to create more engagement with the participants.

General Introduction of the session and the Edited Volume:

- Introduction of presenters and the IFAC Industry Committee; Overview of the concepts and framework presented in the Edited Volume (See the abstract in Section I of this document). (15’)

Case Studies:

- Presentation Robotics and Manufacturing Automation: In-depth treatment of this industry sector and its characteristic control problems. The purpose is to give the audience a feeling on what it really means to identify control problems for an industry cluster, and how to generate interest in industry on innovative ideas. This supports two of the objectives of the edited volume: on the one hand to sharpen the insights among researchers and students on the real needs in industry. And to provide industrial practitioners with a framework to translate their day-to-day problems into a research agenda relevant for their sector. (20’)
- Presentation Energy & Power Conversion: In-depth treatment of this cluster and its characteristic control problems. Purpose: same as above. (20’)

Introduction of the Control for Societal scale challenges: Roadmap 2030:

- Presentation: Overview of the document and research areas for Automatic Control. Societal aspects. (20’)

Interactive Wrap up:

- Panel discussion with the presenters: For the research people: what are key learnings from this. For the industrial people: to what extent does this help you in establishing the business case for automatic control in your industry cluster? Wrap up of the session. Final Q&A (45’)

III. Conclusion

We are currently witnessing an evolutionary phase where the complexity of engineering systems is continuously growing and, at the same time, technology is developing towards more digital and data based. These aspects create a major challenge for automatic control to meet the ever-growing stability, performance, safety and reliability requirements. This calls for a new way of looking at those systems and requirements, where multidisciplinary groups of sciences and technologies have to work together to develop new advanced solutions.

Automatic control, as a rigorous discipline that links the abstraction of elegant mathematics with the more concrete aspects of engineering, has a pivotal role in orchestrating the multidisciplinary group to address the societal and technological challenge of our future.

References

[1] Mastellone, S. & van Delft, A. The Impact of Automatic Control Research on Industrial Innovation: Enabling a Sustainable Future: IEEE Series on Control Systems Theory and

Applications, John Wiley & Sons, 2023, ISBN: 978-1-119-98361-3.
[2] Mastellone, S. & van Delft, A. The impact of control research on industrial innovation: What would it take to make it happen? Control Engineering Practice 111 (2021) 104737.
[3] Lamnabhi-Lagarrigue, F., et al. (2017). Systems & Control for the future of humanity, research agenda: Current and future roles, impact and grand challenges. Annual Reviews in Control, 43(1–64).
[4] Samad, T., et al. (2020). Industry engagement with control research: Perspective and messages. Annual Reviews in Control.
[5] Control for Societal-scale Challenges: Road Map 2030, edited by Anuradha M. Annaswamy, Karl H. Johansson, and George J. Pappas.

BIOGRAPHIC INFORMATION

Prof. Dr. Silvia Mastellone is Professor for Signals and Systems at the Institute for Electric Power Systems in the School of Engineering, University of Applied Sciences Northwestern Switzerland (FHNW), Switzerland. She worked as Principal Scientist at ABB Corporate Research Center in Switzerland. She is one of the principal investigators and Equal Opportunity Officer in the NCCR-Automation, and a member of the advisory board for the multiutility company IBB. She currently serves as the VP of Finances for the International Federation of Automatic Control, and as member of the CSS Board of Governors. She is member of the IFAC Industry Committee.

Prof. Dr Alisa Rupenyan holds the endowed professorship in Industrial AI from the Rieter foundation at the ZHAW Centre for AI, Zurich University of Applied Sciences, and specializes in continuous optimization and automation of manufacturing processes and motion systems. Previously, she was group leader for Automation at Inspire (a Swiss institute for research and technology transfer partnering with ETH Zurich) and senior scientist at the Automatic Control Laboratory at ETH Zurich. Her research interests include autonomous machines, decision-making in industrial settings, and process control. She is a technical committee member at IEEE-CSS and IEEE-IES, and executive member at the IFAC Industry Committee.

Dr. Tariq Samad is Senior Fellow and Honeywell/W.R. Sweatt Chair in Technology Management/Director of Graduate Studies, M.S. Management of Technology/Adjunct Faculty, Department of Electrical and Computer Engineering at the Technological Leadership Institute, University of Minnesota (USA). Prior to joining the University of Minnesota, Dr. Samad spent 30 years in Honeywell International, retiring as Corporate Fellow. He is the former chairman and current executive member of the IFAC Industry Committee.

Pieder Jörg received his M.Sc degree 1995 from the Swiss Federal Institute of Technology, Zurich. He joined ABB at Corporate Research in the area of power electronics. In 2002 he joined the business unit Medium Voltage Drives as head of product development. Since 2010 he is focusing on business and technology development for demanding drives applications. He has been involved in various studies and improvement projects involving large VSD driven systems with demanding rotor dynamics. He currently serves as Corporate Executive Engineer in ABB's Motion Service division.

Dr. Alex van Delft is currently working as independent consultant. Until 2020 he was Corporate Manager Process Control for Royal DSM in The Netherlands, the company he joined after obtaining his PhD at Eindhoven University of Technology in 1989. From 2010 until 2020 he was also chairman of WIB, the Dutch-Belgian Process Automation end-users Association); He is executive member of the IFAC Industry Committee.

Dr. Efe C. Balta received the B.S. degree in manufacturing engineering from the Faculty of Mechanical Engineering, Istanbul Technical University, in 2016, and the M.S. and Ph.D. degrees in mechanical engineering from the University of Michigan, Ann Arbor, MI, USA, in 2018 and 2021, respectively. He was a Post-Doctoral Researcher with the Automatic Control Laboratory (IfA), ETH Zürich between 2021 and 2023. Since September 2023, he has been leading the Control and Automation research group at inspire AG. His research interests include control theory, optimization, statistical learning, robotics, cyber-physical systems, and additive manufacturing.