

# Towards a Community Vision of Integrated Engineering

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**Abstract**—This special session aims to engage the audience in a conversation about integrated engineering, a transdisciplinary approach to engineering. Participants will learn about the Integrated Engineering programs at Minnesota State University, Mankato (USA), the University of San Diego (USA), and University College London (UK). In an interactive session, participants will discuss the concept of integrated engineering and how it might apply to their programs and students. We hope this will establish a foundation for the community to continue discussion of integrated engineering as an emerging description of engineering learning and practice.

**Keywords**— *integrated engineering, curriculum design, learning approaches, industry relations, student experience*

## I. GOALS OF THE SESSION

The goals of this session are to:

- Engage a new audience of engineering educators in a conversation about integrated engineering, a transdisciplinary approach to engineering
- Describe three different approaches to implementing an integrated engineering program
- Establish the foundation for a community to continue discussion of integrated engineering

The anticipated audience includes all conference attendees interested in learning more about integrated engineering or contributing to a conversation about what integrated engineering can mean for the engineering education community. Individual participant goals could include learning from this approach to broaden the experiences within traditional engineering disciplines or starting an integrated engineering program.

## II. DESCRIPTION OF THE SESSION

### A. Overview

This session is synergistic with the overall conference theme of Envisioning Convergence in Engineering Education where convergence is defined “as integrating knowledge and techniques from multiple disciplines and from both academia and the workforce while also providing students the opportunity to develop their professional skills to competently address

societal opportunities and challenges, such as those related to diversity, equity, and inclusion.”

Excellent examples of this convergence can be found in Integrated Engineering programs, which are emerging throughout the world. In this session, we will feature three of these and provide opportunities for participants to explore how the concept of integrated engineering might impact their programs, industry relations, curricula, and overall student experience.

The programs include:

The Integrated Engineering major at Minnesota State University, Mankato (USA), which is implemented through project-based (Iron Range Engineering and Twin Cities Engineering) and co-op based (IRE Bell) programs offers a Bachelor of Science in Engineering degree [1]. Integration includes industry partnerships for projects and student work experiences, coordination between two-year and four-year schools, and integration across traditional discipline boundaries [2, 3]. The programs have additional program outcomes addressing leadership, entrepreneurial thinking, and inclusion as skill sets that students can demonstrate [4].

Integrated Engineering at the University of San Diego in the USA offers a Bachelor of Science/Bachelor of Arts in Engineering degree [5]. The program focuses on helping students see engineering as sociotechnical. This requires not only a strong technical foundation across multiple areas of science and engineering, but also an understanding of the profound impact engineers have on society. Early thoughts on our vision for this program are described in [6]. Examples of our sociotechnical curricular approach can be found in [7, 8]. Four integrated engineering faculty have been collaborating on a USA National Science Foundation (NSF)-funded grant to reimagine energy education by developing a new “Integrated Approach to Energy” course for second year undergraduate majors informed by culturally sustaining pedagogies [9,10]. Students found our holistic approach particularly beneficial during the emergency remote teaching necessitated by the COVID-19 pandemic [11, 12].

The Integrated Engineering Programme at University College London (UCL) in the UK is not a single degree offering, but a cross-faculty teaching framework and philosophy [13]. It was established to deliberately break down existing departmental silos and create an educational student experience that is authentic and relevant to the future roles and

responsibilities of professional engineers within the increasingly complex world that we live in. [14]

### B. Justification

With the emergence of integrated engineering programs that look very different from each other but are cropping up across continents, it is a good time to have discussions with engineering educators from various disciplines, backgrounds, professional societies, pedagogical viewpoints, and countries about the unifying aspects of integration as seen from different perspectives, how different programs are being implemented, and what others might learn from these experiences. One commonality among the programs is a desire to innovate in ways that were not seen as possible within traditional engineering disciplines. The variation in implementations could be considered a strength in contrast to the homogeneity of experiences within traditional engineering disciplines.

### C. Tentative Agenda

The session format will include brief talks by the facilitators and small group activities centered around specific prompts facilitated report outs. The facilitators have years of experience in designing and implementing learning experiences for students in classes and labs and for colleagues in workshops.

1. Introduction and Goals (5 min)
2. Overview of Integrated Engineering Programs at UCL, USD, Minnesota (15 min)
3. Small group activity and report out #1 (25 min)  
Choose 1 of 3 groups. Do this twice, either by moving to a different group or addressing a second question in your original group.
  - a. How could the concept of integrated engineering affect your home program?
  - b. How could the concept of integrated engineering affect academic-industry relationships?
  - c. How could the concept of integrated engineering affect classroom experiences for students?
4. Small group activity and report out #2 (25 min)  
Choose another group from Item 3.
5. Wrap-up and next steps for articulating a community vision (10 min)

### D. Facilitator Biographies

**Rebecca Bates** is Professor and Chair of Integrated Engineering at Minnesota State University, Mankato, home of Iron Range Engineering, Twin Cities Engineering, and the IRE Bell program. Dr. Bates is a past chair of ASEE's Commission

on Diversity, Equity and Inclusion and is the chair of the ASEE Ethics Committee.

**Susan M. Lord** is Professor and Chair of Integrated Engineering at the University of San Diego. She is a Fellow of the IEEE and the ASEE. Dr. Lord has considerable experience facilitating workshops including the National Effective Teaching Institute (NETI) and award-winning special sessions at FIE.

**Emanuela Tilley** is Professor of Engineering Education and Director of the Integrated Engineering Programme at University College London. She is a Principal Fellow of the HEA (Advance Higher Education) [4]. Professor Tilley has established an international profile in the areas of leading curriculum development and cultural, as well as managerial, change required to support and foster innovation in engineering education within higher education.

## III. OUTCOMES AND FUTURE WORK

We hope to have a discussion that increases awareness of Integrated Engineering from multiple perspectives and establishes the foundation for a community vision moving forward. Because this is an international phenomenon, we plan to lead similar conversations at SEFI (European Society for Engineering Education) [15] and AAEE (Australasian Association for Engineering Education) [16] to reach communities in Europe and Australia, respectively. Feedback from the conversations will be used to articulate a community vision of the breadth of integrated engineering.

### ACKNOWLEDGMENT

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