Entrepreneurs and Champions on the Frontiers of Engineering Education

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Abstract—**This panel session will include stories of specific engineering education innovations from around the world from the Difference Makers themselves, followed by an interactive discussion between panel members and attendees. The interactive forum is intended to create dialogue between those interested in effecting significant change at their own institutions and those who have led similar innovations. The panel will bring together change makers from programs that already have created significantly different, innovative programs and those who may wish to do so, with the aim of highlighting salient themes and results expected to be of interest to future Difference Makers. The panel will be interdisciplinary and global. The discussion of challenges, benefits, and strategies will appeal to a broad audience of computing and engineering faculty, deans, practitioners, and students. This is the first of two related panels:**

Panel 1: Champion and Entrepreneur
Panel 2: Transition, Handoff and Sustainability

Keywords—Innovation, engineering education, change management, sustainability, inclusivity

I. DESCRIPTION AND RATIONALE

This panel presents Difference Makers, specifically highlighting stories of innovators who are extending the frontiers of engineering and computing (E&C) education. This panel includes a group of key E&C program innovators for the purpose of identifying the recent successes that are pushing the frontiers of engineering education forward. Through the experience of recent successes that have pushed the frontiers of engineering education forward, this panel will explore issues surrounding new program innovation and the support and resources needed for both entrepreneurial (new program, new setting) or intrapreneurial (re-working of programs in an existing setting or culture). Specifically the topics will focus on initiation work: championing change and the entrepreneurial work of shaping an educational innovation into a startup:

The Champion: The role of the lead in developing and launching a program innovation.

The Program Entrepreneur: Shaping an educational innovation into a startup.

These key topics are best served by a panel in that the roles appear to be common in the experience of education change, yet also have significantly different stories as to how the roles worked, and how they could work for others in their own setting.

II. AUDIENCE

This panel is expected to draw interest from a broad audience of educators, administrators, and practitioners in all disciplines included in the conference. The Ruth Graham report [1] and other recent literature advocating for change in higher education (*e.g.*,[2]–[6]) has led to thinking about how to adapt education for Industry 4.0 and beyond [7]. The primary audience is engineering and computing educators interested in better understanding how to succeed in creating sustainable educational innovation. This includes E&C faculty, deans, practitioners, and students.

III. GOALS AND FORMAT OF THE SESSION

The panel aims to be more than just the collected stories of different institutions and their stories of making sustained differences in engineering and computing education. Rather, the panel will reflect the work of the Difference Makers pre-conference workshop and the presentations of the individual institutions and their representatives.

The topics are centered on the processes and issues required for initiating program innovation, *e.g.*, The champion with a vision for change, and the entrepreneur: transitioning a startup team into an educational program that delivers value to student and stakeholders. The goals of the panel are to engage the audience into a discussion of both the mechanisms of change, and the work of initiating sustainable program innovation. This will be accomplished by three different phases planned for the panel session:

I. **Introduction/Synthesis:** A brief presentation of the Working Group summary lessons related to transitioning, handoff, sustainability and related topics. This will summarize the key take-aways from the Difference Makers working group (panel leads) and includes collecting questions from the audience.

II. **Summary stories**: These are a series of minimally four stories from individual panelists highlighting their experience and key lessons learned from and what it takes

to prepare for and manage handoff and sustainability of program-wide innovations.

III. **Directed questions**: While the panel presenters are sharing their stories and lessons learned, the panel organizers will collect questions from the audience and organize them by topic. These will be used to initiate the discussion and audience interaction. The intent is to allow audience themes to be addressed and spark conversation.

IV. PANEL FACILITATORS

Elizabeth Pluskwik, Ph.D. leads the Engineering Management and Statistics competencies at Iron Range Engineering, a project-based engineering education program located in northern Minnesota. Her research interests include gamification, entrepreneurship & innovation in engineering, cooperative learning, and engineering management.

Jim Morgan, CPEng, P.E., Ph.D. is Professor of Engineering at Charles Sturt University. Before joining CSU Engineering as the Inaugural Course Director in 2015, he spent over 30 years on the faculty of the Zachry Department of Civil Engineering at Texas A&M University. In addition, he was active in the NSF Foundation Coalition project and directed the first-year engineering program while at A&M. His research focus is STEM and engineering education.

Deacon Steve Frezza, P.S.E.M. leads the Software Engineering program and is chair of the Computer and Information Science department at Gannon University. He had led or helped lead the introduction of three new degree programs at Gannon. His research interests are in the areas of philosophy of engineering, software engineering education, and the relationship between engineering and theology.

V. PANEL MEMBERS

Panel members will describe one or more of these topic areas from their program innovation experience that is of value and interest to other engineering and/or computing educators. They will describe the setting for their program innovations, motivations for their program innovation, and a summary of the approach or results obtained. Core questions include:

- What program innovation are you most proud of? What were most successful?
- What were the most important lessons learned?
- What was learned that would be most interesting to others considering major program innovation?
- What part of your story would impact others considering change?

Planned panel topics and members include:

A. An Innovative Interdisciplinary Undergraduate Data Science Program: Pathways and Experience

Bojan Cukic, *University of North Carolina, Charlotte, Charlotte, NC, USA* have developed an independent new major that centers on data analytics application domain(s). This includes a core set of Data Science Studios, a series of six credit hour studio courses in each of the four academic years. Co-taught by instructors from at least two traditional departments, the studio courses engage students as active learners while solving ethically complex, real-world challenges. These are cross-disciplinary courses designed, taught and maintained as cross-departments faculty: e.g., one from statistics/ mathematics/ computing and the other from a social science discipline (sociology, urban studies, public policy, criminal justice, etc).

B. Offering an Entrepreneurship Course to All Engineering Students: Lessons Learned from ING2030 in PUC-Chile

Isabel Hilliger, Constance Fleet, & Constanza Melian *Pontificia Universidad Católica de Chile, Santiago, Chile*. This innovation focuses on the integration of a technology-focused entrepreneurial experience course into all 3rd-year engineering programs across PUC. To continuously improve this course, the Engineering Education Unit at PUC-Engineering has been conducting pre- and post-surveys, assessing self-efficacy and learning benefits related to various activities and evaluations of the course. With strong evidence of continued successful impact, this cross-institution innovation story describes the main lessons learned from using a data-centric, continuous-improvement approach in consecutive terms. By focusing on enhancing the highest perceived benefits, assessment data has helped continuously improve the course and its value to students.

C. A Transformative Engineering and Architecture Education for the 21st Century

K.L. Pey, *Singapore University of Technology and Design* (SUTD) explains the creation of a brand-new university innovating both in program design and organization. Their degree programs focus on addressing human-centric issues and problems in engineering and architecture. Formulated around a project-centered, design-focused curriculum to create products, services, systems and built environments, students engage in small group-, active- or peer-to-peer learning in a dedicated cohort environment Consequently the SUTD programs foster teamwork and a collaborative spirit in formulating and sharing solutions beyond the team. To sustain change, SUTD adopted an 'pillar' structure, without colleges, faculties, departments and even divisions to encourage seamless and boundary-less collaboration in education and research across all faculty.

D. The Startup: Iron Range Engineeering

Ron Ulseth, Rebecca Bates, *Iron Range Engineering* (IRE) meet a need for regional economic development and the desire to provide a high quality, more balanced education for students. These innovations deliver on developing professional and design competence leveraging student-centered, experiential pedagogies to ensure a more impactful learning experience. Starting with project-based learning (PBL) from the Aalborg model [8], changes welcomed by industry. Continuous improvement has seen the student experience changed by 10-20% each semester as new strategies were developed, tested, and improved.

These personal stories of the innovative program leaders are expected to be highly valuable to others who plan to undertake educational innovations at their home institutions.

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