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Shaping the Engineering Leadership Research Agenda: Results of a 2022 Special Session

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Abstract

Engineering leadership (EL) research publication has seen significant growth coinciding with the ever-increasing recognition that leadership development is an essential component of undergraduate engineering student development. To support the continued growth of this nascent field, reflection on past research history combined with recognition of current and future challenges is vital to developing a relevant research agenda. Such a research agenda may inform future growth by meeting intellectual demand with relevant insights informed by prior work. An end-goal of the EL research enterprise is strengthening the field's impact on the EL community and the engineering education field more broadly. A substantial portion of the research on EL is published through the American Society for Engineering Education (ASEE). In particular, EL thought leaders often publish through a division focused on supporting EL education, educators, and researchers, the Engineering Leadership Development Division (LEAD).

The purpose of this paper is to report the results of the 2022 ASEE LEAD special session entitled *Imagining the Research Agenda for ASEE LEAD*. This special session was hosted by LEAD and brought together a diverse group of thought leaders from the EL community to provide an interactive opportunity to imagine the future of ASEE LEAD's research agenda. To identify the current state of the ASEE LEAD research agenda, the session considered the recently published book *New Directions for Student Leadership: No. 173. Student leadership development in engineering* and a review paper of all articles related to leadership published at the ASEE annual conference between 1996 and 2021. Interactive small group design activities built on this foundational knowledge to imagine future directions for the Division's research agenda over the next 5-10 years. Following the session, a thematic analysis of session artifacts helped synthesize a set of priorities for the Division's research agenda. All artifacts were digitized and then independently analyzed by two of the session facilitators to independently identify themes across the artifacts. The facilitators then convened to adjudicate discrepancies until a common set of themes emerged. These results informed the ASEE LEAD executive committee's path forward and formulation of the 2023 ASEE LEAD call for papers. For EL researchers, this paper provides insights into relevant research topics that may be considered in the coming years. For EL educators and practitioners, this paper frames the current state of the community's knowledge gaps and provides insights into the discipline's future directions.

Introduction

For nearly three decades, the engineering community and society have realized that engineering work has a direct impact on society and the world in which we live [1], [2]. Developing engineers for future work is socio-technical in nature; success in modern engineering projects requires more than technical capability, but also the ability to manage teams of people and lead them towards the

accomplishment of common goals. Adapting to this new socio-technical reality has brought a recognition that holistic engineering design techniques and professional skills development, (to include leadership and management) of engineering students are critical learning requirements for engineering students [3]. Engineering programs and engineering education research have invigorated work focused on developing students' teamwork capacity, communication effectiveness, management capability, etc. These professional skills and the requirement to address socio-technical challenges merge in the recognition that holistic engineering education requires the development of engineers that can lead and manage others.

Though definitions of Engineering Leadership (EL) may be as varied as those who attempt to define it [4], for the purposes of this paper, we rely on upon the definition by [5], who synthesized disparate definitions in support of undergraduate engineering educators:

> Engineering Leaders 1) employ the full range of engineering skills and knowledge in the design of socio-technical innovations while 2) seeking to understand, embrace, and address the current and future impact of their work in context by 3) actively fostering engaged and productive relationships with diverse stakeholders, including themselves and their team, the users of their technologies, and those impacted by their engineering work.

The call for increased focus on professional skills in holistic engineering education has remained consistent for nearly three decades [1], [2], [6]. These calls were answered by and evolution in student outcomes for ABET accreditation which for 2022-2023 include both EL and EM capabilities, "an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives," [7].

The EL research and education community of practice is at an inflection point [8] as nearly a decade of rapid growth in EL scholarly work must be capitalized upon for future work. Three decades of emphasis on engineering leadership as a part of the larger professional skill development has led to the development of over 50 EL programs in North America, and community of practice has emerged to address programmatic and research needs. ASEE's Engineering Leadership Development Division (LEAD) [9] was established in 2014 and Canada's National Initiative on Capacity Building and Knowledge Creation for Engineering Leadership (NICKEL) was established in 2016 [10]. These organizations have made tremendous strides to coalesce the community of practice through conferences, workshops, and research to form the EL discipline, sparking rapid growth in scholarly publication [8] and enabling the recent publication of an EL handbook for EL educators and researchers [13]. Recent literature reviews have independently suggested requirements to assess leadership development within curriculum, programs, and training initiatives across all disciplines [8], [11], [12]. Considering these findings, members of the ASEE LEAD executive committee established a special session at the 2022 ASEE Annual Conference and Exposition to invite ASEE Lead members to shape the future research agenda of the EL community of practice.

This paper synthesizes the group work of ASEE LEAD members who participated in the special session of the 2022 ASEE Annual Conference entitled *Imagining the Research Agenda for ASEE LEAD* that was hosted by the authors. This special session was hosted by LEAD and brought together a diverse group of thought leaders from the EL community to provide an interactive opportunity to imagine the future of ASEE LEAD's research agenda. The authors led this interactive special session to encourage a breadth of thought related to the future of the LEAD division's research agenda. This synthesis addresses the following research question:

> *What research themes emerged from the participants of a 2022 ASEE LEAD special session considering the future of the ASEE LEAD research agenda?*

Methods

The 90-minute special session was orchestrated by the authors to elicit thoughts regarding future directions for the ASEE LEAD research agenda. The nineteen participants in the special session were from a breath of higher education engineering leadership experiences that included faculty in engineering leadership programs and graduate students to members of the ASEE LEAD Executive Committee. During the 90 minutes, participants self-selected into three working groups based on which table they chose to sit during the session. Throughout the session, participants conducted four design activities: 1) "Bug List Generation", 2) "Bug" Opportunity Development, 3) Solutions Development, and 4) ID Next Steps. After a brief orientation to the session agenda, the participants were prompted following sensitizing question, "What "Bugs" you about the EL Body of knowledge?" Participants were asked to write down their resulting "Bug Lists" in sticky notes while two of the authors provided two 10-minute talks which oriented the participants to 1) a recently published book [13] and 2) a literature review paper [8]. These orientations served as sensitizing experiences that provided context regarding the current state of research topics within the EL education community. Following the talks, the participants were given fifteen minutes to conduct affinity diagraming and mapping of their "Bug Lists" using butcher paper to develop "Bug" Opportunities. During this activity participants sorted their topics into groupings and sub-groupings, ultimately labeling each grouping to identify the associated theme. Groups then shared preliminary results with the rest of the participants. Upon completion of the orientation, groups were given about 30 minutes to identify solutions to the "Bug" Opportunities which could help guide future EL research. This activity followed a *think-pair-share* type format with an associated worksheet (Figure 1). After each group completed sharing their group's identified solutions, each participant was finally asked to commit to action by identifying their individual next steps toward the identified solutions and providing recommendations to the ASEE LEAD executive committee for their next steps.

Figure 1: Solution Development worksheet.

Following the session, one of the authors digitized the hand-written artifacts for virtual collaboration. A thematic analysis of session artifacts helped synthesize a set of priorities for the Division's research agenda. The digitized artifacts were independently analyzed by two of the authors to independently identify themes across the artifacts. The authors then convened to adjudicate discrepancies until a common set of themes emerged. These results were presented to the ASEE LEAD executive committee to formulate the 2023 ASEE LEAD call for papers. Because members of the ASEE LEAD executive committee participated in the special session, the authors were able to conduct member checking [14] of the results to add validity to the work.

Limitations

As a post-hoc, qualitative analysis of a special conference session, we acknowledge the limitations associated with using the lens of participant design artifacts as the primary data set. As mentioned previously, this study incorporated an element of member checking to ensure research quality. The participant discussion only provides a pilot group that can be used as a baseline for future thought. The

resulting research agenda proposals set forth in this paper are by no means exhaustive, rather they reflect a snapshot in time of one particular group's thoughts.

Results and Discussion

The 90-minute session during the ASEE conference was grounded in findings from [8] and the recent publication of [13]. Participants, directed to create a bug list and work as groups to develop associated research opportunities, provided recommendations for the future of EL research. The themes generated from these activities are listed below and further refined to support the LEAD Divisions' strategic directions for the 2023 call for papers. A key question for each LEAD Strategic Initiative (Inform, Design, Explore, Assess) (Figure 2) was generated to support the call for papers for the 2023 ASEE LEAD Division.

INFORM
Document the need for and value of engineering leadership (EL) education in university and workplace contexts

EXPLORE
Examine leadership theory and/or practice in engineering education or workplace settings.

DESIGN
Demonstrate evidence-based practices for designing, implementing, and sustaining EL programs

ASSESS
Evaluate the impact of curricular interventions, EL development models, or EL programs on engineering students and professionals.
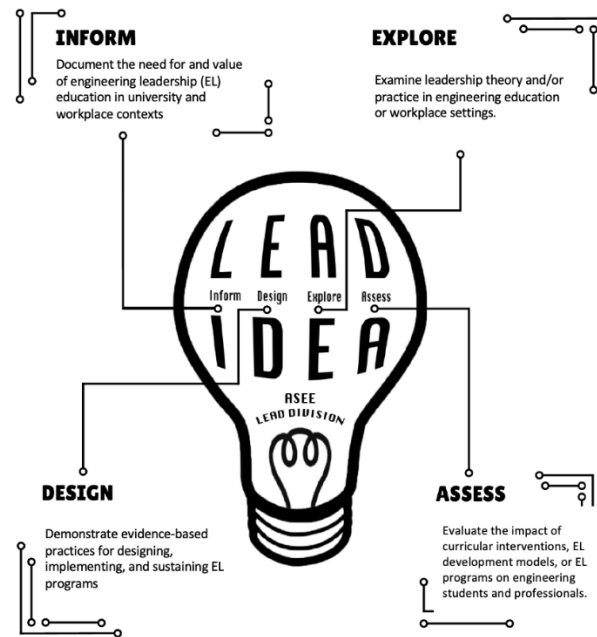
Figure 2- LEAD IDEA Strategic Plan

Table 1 captures the research opportunities identified by the table groups as a part of the session. The authors used these opportunities generated by the table groups as discussed during the session and a post-hoc analysis of the associated "Bugs" to discern meaning of

each opportunity listed. From there, the authors negotiated opportunity convergence until session-level themes emerged and are listed next.

Table 1: Group-Developed Engineering Leadership Research Opportunities

Group A	Group B	Group C
Opportunity 1: Assessment	Opportunity 5: Assessment	Opportunity 10: Defining EL Field maturity
Opportunity 2: Integrating EL into practical settings	Opportunity 6: Benchmarking Standards	Opportunity 11: Faculty Dev.
Opportunity 3: EL multidisciplinary foundations	Opportunity 7: Justification (ROI)	Opportunity 12: EL Skill Dev.
Opportunity 4: EL Self-Reflection	Opportunity 8: Rigor in Research	Opportunity 13: Self
	Opportunity 9: Identity/DEI	Opportunity 14: Systems

Theme 1- Integration Across Curriculum

Integration across curriculum emerged as a theme from opportunities 2,3,7,10, and 14. This theme suggested a stronger emphasis on leadership education throughout the engineering curriculum. ABET's current leadership-related student outcome 3.5 requires engineering program students to demonstrate, "an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives," [7]. This student outcome suggests a requirement for students to grasp and apply leadership principles in team-based work but lacks a direct outcome for educational institutions to pivot for an integrated approach to leadership education in engineering. Participants suggested this lack of integration prohibits the ability for students to link and apply leadership into specific "technical domains and critical skills sets" relevant for various disciplines. Opportunity 3 further identified the interdisciplinary foundations of engineering leadership and suggested a need to include Industrial and Organizational Psychology and Human Factors Engineering which forces the engineering leadership research community to look past traditional leadership theories and expand into other disciplines that explore leadership from the lens of other orientations and contexts. This theme led to the first key question for the call for papers for the ASEE LEAD division which related to the *Inform* objective:

Inform: Document the need for and value of engineering leadership (EL) education in university and workplace contexts.

Key Question for 2023: How is EL being integrated across the curriculum?

Theme 2- Think Bigger

The general theme of "think bigger" emerged in the recommendations for the future of engineering leadership. This idea suggested that the future of engineering leadership research needs to examine cultural differences and the impact of different cultural context on leadership. This theme emerged from opportunities 4,9,13, and 14. Participants used the term "conventional wisdom" inferring the need for expansion past traditional notions of leadership, which is a key finding in [15] reflecting engineer's identification with leadership. The think bigger concept also suggests a bigger connection to Diversity, Equity, and Inclusion and highlights the lack of a focus in engineering leadership literature related to inclusive leadership within the engineering context. A "lack of attention to systems" was used to describe the bigger picture of the needs for inclusive leadership training and education from a macro perspective. This theme led to a second key question for the call for papers for the ASEE LEAD division which related to the *Design* objective:

Design: Demonstrate evidence-based practices for designing, implementing, and sustaining EL programs.

Key Question for 2023: What diverse models/theories of leadership are being incorporated into EL programs or curricula?

Theme 3- Feedback loop from Industry/Alumni to Academia

This theme was driven by a specific question asked rhetorically by a table group during the session, "Does industry drive engineering leadership needs or do they help to support EL educational efforts driven by educational institutions?" as well as opportunities 10, 11, 12, and 14. This theme was grounded in the need for industry and alumni involvement, particularly a feedback loop. Research that supports the integration of industry feedback of educational strategies in EL as well as awareness of workforce needs is imperative for the future of EL research. Creating faculty connections to industry was another element of this theme. The connection to industry and alumni was also connected to the development and understanding of EL interventions from a longitudinal perspective. Connecting industry and alumni could support research efforts post-secondary educational intervention efforts, specifically connecting a study of EL from college to early career. This theme led to a third key question for the call for papers for the ASEE LEAD division which related to the *Explore* objective:

Explore: Examine leadership theory and/or practice in engineering education or workplace settings.

Key Question for 2023: How do you describe, assess, and/or test the transfer of EL development from academic settings to the workplace?

Theme 4- Assessment- How to move forward?

Assessment has been a recurring discussion and concern for the EL research community [8]. The conversation during the 2022 ASEE LEAD special session, highlighted many of the enduring challenges to include unclear EL vocabulary, unclear definitions, and a lack of an agreed upon competency and characteristics model. Opportunities 1, 5, and 6 emanated from these conversations. The special session groups proposed to address those concerns with the creation of EL standards. From a research perspective, this theme further reflected ideas of harnessing existing models that have been validated in literature. Specific ideas included conducting a literature review of effective assessments that have been used in current studies as well as leverage LinkedIn to collate industry assessment tools used in the engineering context. Participants suggested that a meta-analysis of these proposed research studies could lead to the endorsement of an assessment tool by the ASEE LEAD Division. This theme led to a third key question for the call for papers for the ASEE LEAD division which related to the *Assess* objective:

Assess: Evaluate the impact of curricular interventions, EL development models, or EL programs on engineering students and professionals.

Key Question for 2023: What assessment tools are EL programs using and what are the findings from applying those assessment tools?

As noted above, the overall themes discussed with the LEAD Division executive committee were then massaged into the key questions that aligned with the LEAD Division's strategic objectives (Figure 2). The totality of this process allowed the division to better consider member experiences and expertise in crafting a call for papers that aligned with current thoughts, gaps, and trends in EL. Table 2 provides a summary of the output from the session by linking LEAD strategic objectives, themes that resulted from the special session, and key questions that were incorporated into the 2023 LEAD call for papers. One area to improve for the future would be to ensure industry representatives are present in the conversation. This would better achieve the LEAD Division's strategic initiative EXPLORE to ensure that workforce needs are also considered for future research.

Taking the output from this conversation and putting it into practice resulted in the key questions for the LEAD Division call for papers for 2023 and it also resulted in strategic decisions for other division initiatives. The first Leader Lounge, an online gathering of EL practitioners and educators to discuss key topics, of 2023 aimed at the ASSESS strategic initiative and focused on challenges with assessment of EL programs and ideas for moving forward. Collecting the information through the generative discussion and problem-solving approaches of the 2022 workshop provided an opportunity to bring the EL community of practice together to make decisions and foster strategic conversation that meet the needs of the growing area of EL research. The approach allowed for many voices to be heard, provided depth to ongoing conversations on EL research, and sets a direction for future conversations.

Table 2: Crosswalk of special session results

Special Session Theme	LEAD Strategic Objective	Key Question
Integration Across Curriculum	Inform	How is EL being integrated across the curriculum?
Think Bigger	Design	What diverse models/theories of leadership are being incorporated into EL programs or curricula?
Feedback loop from Industry/Alumni to Academia	Explore	How do you describe, assess, and/or test the transfer of EL development from academic settings to the workplace?
Assessment- How to move forward	Assess	What assessment tools are EL programs using, and what are the findings from applying those assessment tools?

Conclusion

The 2022 ASEE LEAD special session identified four themes that informed the development of the 2023 ASEE Annual Conference LEAD call for papers. The session brought together a diverse set of ASEE LEAD members and EL educators. The session allowed participants to consider the current state of the EL research and co-construct a proposed research agenda for the community of practice. Although not an exhaustive or definitive list of research opportunities for the EL community, this effort has allowed LEAD to capture the voice of its constituents in determining the direction of future research conversations.

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