Routledge
Taylor & Francis Group

EDITORIAL

Check for updates

The Early Career Years of Engineering: Crossing the Threshold Between Education and Practice

In studies of engineering practice, the early career phase is a particularly intriguing area of inquiry. It is frequently imagined as the time when more-or-less competent graduates enter the workforce and launch successful careers, often in large corporate organizations and supported by various types of onboarding programs. Yet this kind of idealized representation belies a much more complex reality, one in which many engineering graduates pursue careers on the edges (or outside) of engineering, navigate complex organizational socialization and identity development pressures, and grapple with unexpected competency demands. In school and at work, early-career engineers might additionally encounter calls to be more entre/intrapreneurial, multidisciplinary, innovative, culturally competent, and/or socially conscious – but without acknowledging that some of these attributes may conflict or poorly align with certain industries or job roles. Further, rapid changes in technology, markets, organizational structures, and demographics – to name just a few – continue to reshape and transform engineering work across all career stages. Against this complex and ever-changing backdrop, research investigating the actual lived experiences of early-career engineers helps explore the relationships between engineering education and practice, including preparation of engineering students for the realities of entering the workforce.

Calls for study of this important segment of engineers' careers have appeared in the literature as early as the 1980s, with Sara Rynes[1] noting, in her study of early-career engineers transitioning to manager positions, how it was "curious that so little research has examined engineers at earlier career stages." Since then, an increasing number of researchers have published studies on early career engineering practice; however, such research has remained somewhat limited in scope due to the complexities of the space, the changing demographics of engineering students, and the dynamic nature of engineering practice. For example, Nadya Fouad and colleagues[2] identified a lack of focus on the early-career years in research on women engineers' persistence, while Reed Stevens, Aditya Johri, and Kevin O'Connor[3] observed a need for research that "examines directly the specific learning processes of engineers making the transition from school to work." Even within *Engineering Studies*, where a substantial body of work has attended to engineering formation and engineering work, articles have not particularly focused on the continuation of engineering formation after graduation or the influence of engineering work on organizational newcomers, save for a few exceptions.[4]

The articles in this special theme issue help narrow the gap in work on early-career engineering practice and the engineering school-to-work transition by further examining the dynamic and complex day-to-day realities of early-career engineering work. These insights, in turn, offer a deeper understanding of and support for the training of current and future engineering professionals. The impetus for this special issue originated at a 2018 National

Science Foundation-sponsored Research on Engineering Practice (REP) Workshop[5] held at Santa Clara University in Santa Clara, California, USA. Organized by the authors of this editorial – four researchers at different points of intersection between engineering studies and engineering education – the workshop convened 27 academics, engineering practitioners, and government officials from diverse disciplinary backgrounds, areas of expertise, and research interests. The workshop's overall aim was to advance knowledge and visibility of research on engineering practice to improve how engineers are educated. Over two days, participants engaged with questions about what it means to do engineering work, who gets to be an engineer, how engineering graduates can be prepared more effectively, and how engineering practice might be transformed to better serve engineers, employers, and the public.

Early-career engineering practice and the school-to-work transition organically emerged as a specific focus of the workshop – and then later coalesced in the four articles in this special issue submitted by invited workshop participants. Notably, the workshop catalyzed a research agenda to increase the scope, scale, and sustainability of research on all facets of engineering practice. Key topics identified include: 1) the nature of engineering practice as it happens across varied contexts, settings, and timepoints; 2) who identifies as an engineer or does engineering and the varied contexts, experiences, and interactions that determine this; 3) how engineering ways of doing, knowing, learning, and thinking are developed, supported, and enacted through various formal and informal mechanisms; and 4) the non-normative pathways that individuals take into, through, around, and out of engineering, from preparation and first entry to full engagement and eventual departure. The development of new methods and infrastructures to support research on engineering practice – including to gain access to potential research sites, broaden the methods used to study practice, and increase conversations about methods and frameworks – also received considerable attention among participants.

This sought-after diversity of frameworks, methods, and topics (except, perhaps, non-traditional pathways, to which we return later) is on full display in the articles comprising this special issue. We anticipate readers will find it interesting and instructional to notice, in addition to each article's findings, the similarities and differences among the choices made for each article. All four articles employ qualitative studies to examine early-career engineering practice and the alignment between engineering work and education. All are based on interview data, in one case supplemented by evidence drawn from reflective journals. Yet each paper showcases contrasting methodologies for reporting findings, ranging from a single narrative to brief case narratives of a few participants to thematic analysis based on evidence from a dozen participants. Each article also applies a novel theoretical approach to illustrate and highlight specific facets of early-career engineers' experiences and challenges as they move into organizations, including competencies and competency demands, identity development, organizational structure and context, and intersectional power and privilege, among others.

We start with Brent Jesiek, Natascha Buswell, and Swetha Nittala's[6] piece, which uses three constructed narratives drawn from a thematic analysis of twenty-three participants to explore the boundary-spanning that occurs across role, activity, and boundary types in early-career engineering practice. The authors find that the ubiquity of boundary-spanning instances in their data makes boundary-spanning an appropriate framework for studying engineering practice. They demonstrate the importance of being able to span inter- and

intra-team, workgroup, and organizational boundaries in addition to those pertaining to personal characteristics, time, and space. Most of all, they emphasize the sociotechnical nature of boundary-spanning, noting that neither the social nor technical aspects of engineering work supersede one another but rather happen in concert or cannot be fully separated. That is to say, the technical challenges early-career engineers encounter in their daily work often have embedded social components in them (e.g., communication, coordination) that must simultaneously be navigated, and *vice versa*. Lastly, Jesiek *et al.* reveal a clear career progression for early-career engineers marked by ever-changing work demands and expectations, involving the interplay among technical expertise, competency demands, and engineering identity, and perhaps also tinged with gender and racial dynamics – a phenomenon on which other papers in the issue also comment.

Next, Christopher Gewirtz and Marie Paretti[7] adopt a figured worlds framework of identity for the narrative of a single participant's first two years of work. From longitudinal interviews with the engineer over two years, the authors find her work experiences and professional identity to be shaped by both individual agency and the organizational structures within which she works. Similar to Jesiek *et al.* (2021), they foreground the sociotechnical components of engineering practice – looking, for example, at the study participant's ability to apply her technical expertise and execute technical tasks within the confines of her organization and assigned work role. Gewirtz and Paretti argue that tensions between competing conceptualizations of engineering, i.e., for public service on the one hand and corporate gain on the other, produce tensions that early-career engineers may need to navigate throughout the initial years of their careers. Further, they suggest that while holistic approaches to engineering education have been offered as a solution to (among other things) these kinds of issues, such approaches fall short of setting students up to succeed as practitioners and, given the unrealistic expectations about the realities of engineering work they convey, may even be counterproductive.

While Jesiek et al. (2021) and Gewirtz and Paretti (2021) implicitly touch upon organizational socialization, Benjamin Lutz and Marie Paretti[8] tackle this issue more directly in their exploration of the social and cultural dimensions of engineers' learning during the student-to-professional transition. The authors use theories of organizational socialization to thematically analyze reflective journals and semi-structured interviews from twelve recent engineering graduates. They deliberately choose to bracket off the technical aspects of early-career engineering practice in order to raise up and make more visible the sociocultural aspects such as forming relationships, learning the language, and navigating organizational culture. Lutz and Paretti wield this focus to underscore the differences in context that engineers experience as they move between education and work settings. They close by urging educators to become more knowledgeable about organizations so they can help students better maneuver through the social and cultural dimensions of engineering work.

Lastly, Kacey Beddoes[9] observes that despite the recognized importance of early-career socialization experiences in relation to key career outcomes, no model of organizational socialization explicitly focuses on the experiences of different demographic groups, particularly women and minoritized individuals. Beddoes addresses this issue by presenting brief narrative examples from three early-career women engineers of diverse backgrounds. Through accounts of each woman's negative interpersonal workplace interactions during their first year of post-school employment, she allows for nuanced understanding of how

both group and individual identity afford privilege (or lack thereof) to organizational new-comers. While Beddoes focuses mainly on race, ethnicity, and gender identity, she also at various points shines a light on nationality and religion, demonstrating the differential and intersectional effects each of these characteristics can have on task, status, and reward allocation.[10] Like Lutz and Paretti, Beddoes purposefully brackets off the technical aspects of engineering work to elevate the sociocultural ones. Even still, the piece references the gendered and racialized nature of perceived technical expertise within the field, bringing the technical aspects in at the edges. Beddoes also poses a pointed question highlighting the need for further work on equity and social justice issues in the early career years, which we paraphrase thus: if newcomer engineers experience such challenges so early in their careers, how can we expect different for them in the future?

Taken together, the articles in the issue provide a multi-prismatic, collage view into early-career engineering practice, with overlaps and commonalities, even though each paper offers a different topical emphasis and methodological approach. We find the conver-gences in their findings despite these differences quite striking. The four articles all stress the technical, social, and cultural aspects that simultaneously comprise early-career engi-neering work. They emphasize the importance of being able to influence the work and decisions of others for advancement and promotion while noting structural barriers that early-career engineers may experience because of or due in part to their gender iden-tity, racial identity, experience level, and other personal characteristics. Each piece also helps reframe our understanding of engineers' preparation, moving away from prevail-ing narratives in which newly degreed engineers struggle to apply technical and profes-sional competencies on the job. Instead, the articles present narratives in which newly degreed engineers continuously bump up against the non-technical forces that shape engi-neering jobs and for which school simply does not prepare them. That is, engineering education appears to largely ignore the sociocultural facets of engineering work because the associated competency demands are not well-aligned with academic models whose main objective is to maximize technical prowess. And, as all the authors point out in one way or another, such inadequate socialization leaves newcomers vulnerable to confusion, disillusionment, unfair disadvantage, and even exploitation.

The articles in this issue clearly demonstrate the importance of studying early-career engineers. Indeed, the differences between what engineering students learn in school and what constitutes success on the job in an organization are often most salient among new-comers in transitional periods, after which one tends to settle into more stable job roles and career patterns while losing awareness of such differences. Still, the field has more work to do, and more gaps to bridge, to advance research on engineering practice during the early-career years and beyond. We conclude with a call to action around three key themes that emerged from the 2018 NSF workshop.

First, there is a need to further advance knowledge about the nature of engineering practice, conduct research into new areas identified by the community as important, and creatively tackle issues of participant access and recruitment. Especially vital are studies that push the definitions and boundaries of engineering practice, such as those focusing on non-normative pathways to engineering careers (e.g., community college, non-engineering degrees), different contexts for doing engineering work (e.g., in startups, government, public, and nonprofit organizations, maker spaces, contract work, etc.), as well as specific underrepresented populations and a wider range of disciplines and industry sectors. We

also recognize that existing ways of studying engineering practice are limited in that they rarely involve direct observation of professional work, e.g., via ethnographic field studies. Thus, we need more attention to existing and emerging methods and strategies for studying engineering practice, such as the various ethnographic fieldwork approaches being explored by Brent Jesiek, Aditya Johri, Cory Brozina, and Russell Korte[11].

Second, the times also warrant a greater focus on translational research and approaches for making the findings of research on engineering practice more accessible to reach a variety of relevant audiences. For example, during the REP workshop mentioned above, calls were made to "stop writing only for ourselves" (i.e., meaning other engineering education and social science researchers) and revisit current incentive structures that prioritize peer-reviewed journal and conference papers to place greater emphasis on outcomes and deliverables likely to have more immediate and measurable impact. Participants also emphasized wanting to bring more voices into the conversation and working collaboratively with engineering educators, practitioners, employers, policymakers, and professional societies. Here we take considerable inspiration from Gary Downey's earlier call in this journal to grow what he calls "scalable scholarship," including by imagining how our research outcomes can grow to include more participation and critical engagement in various stakeholder communities, such as disciplinary professional societies, industry groups, NGO and governmental policymaking bodies, etc.[12]

Third and finally, we strongly encourage greater synergy between the engineering studies and engineering education communities. As alluded to earlier, the number of published works and research projects that are wholly or mainly concerned with studies of engineering practice continues to expand, and this special issue contributes to that growth. Yet, more scholarly collaboration is needed to reach a critical mass that can keep pace with the rapidly evolving nature of engineering practice. We propose that the way to build that critical mass is to situate research on engineering practice at the intersection of engineering studies and the much larger and more established field of engineering education. Whereas engineering education research has been primarily concerned with developing engineering graduates who are better prepared to meet the competency demands of engineering careers (the *formation* of engineers), engineering studies research tends to focus on creatively reimagining engineering practice to better serve society (the *reformulation* of engineering). For research on engineering practice to further mature and evolve, each community needs to reach across these and other disciplinary boundaries (e.g., sociology, anthropology, psychology, business) and leverage each other's expertise.

How can we accomplish this aim? To start, engineering education researchers could experiment more frequently with new theoretical and analytical perspectives, attend more critically to the inherent social and cultural assumptions underlying engineering education and practice, and consider more broadly the implications of their work for change, reform, and innovation. For their part, engineering studies researchers could consider the more practical and immediate implications of their research for education and practice, focusing not just on what the engineering field can and ought to be but also on what concrete and actionable steps might get us there. Such modest but impactful steps can help bring the engineering education and engineering studies communities closer together, enabling us to learn more about the similar and different ways we approach research, identify points of crossover and common challenges, and even synergize our efforts through shared research investigations, datasets, and infrastructure. With this backdrop, a vibrant

scholarly community interested in using findings from research on engineering practice to continuously revamp and transform our education and work spaces can develop. As researchers committed to this work, we find this opportunity highly compelling, and we invite readers to join the endeavor.

Notes

1. Rynes, "Career Transitions from Engineering to Management," 140.
2. Fouad, Fitzpatrick, and Liu, "Persistence of Women in Engineering Careers."
3. Stevens, Johri, and O'Connor, "Professional Engineering Work," 126.
4. Such as Johri, "Learning to Demo."
5. Brunhaver, Jesiek, Korte, and Strong, "Research on Engineering Practice."
6. Jesiek, Buswell, and Nittala, "Performing at the Boundaries."
7. Gewirtz and Paretti, "Becoming After College."
8. Lutz and Paretti, "Exploring the Social and Cultural Dimensions of Learning for Recent Engineering Graduates During the School-to-Work Transition."
9. Beddoes, "Examining Privilege in Engineering Socialization Through the Stories of Newcomer Engineers."
10. These points are expanded upon in Beddoes, "Gender as Structure in the Organizational Socialization of Newcomer Civil Engineers."
11. Jesiek, Johri, Brozina, and Korte, "Novel ethnographic approaches for investigating engineering practice."
12. Downey, "What is engineering studies for? Dominant practices and scalable scholarship."

Acknowledgements

References

Beddoes, Kacey. "Examining Privilege in Engineering Socialization Through the Stories of Newcomer Engineers." *Engineering Studies* 13, no. 2 (2021): 158–179.

Beddoes, Kacey. "Gender as Structure in the Organisational Socialisation of Newcomer Civil Engineers." *European Journal of Engineering Education* (In press).

Brunhaver, Samantha, Brent K. Jesiek, Alexandra C. Strong, and Russell Korte. "Research on Engineering Practice: Catalyzing a Scholarly Community." Paper presented at the Frontiers in Education (FIE) Conference, San Jose, CA, 2018.

Downey, Gary. "What is Engineering Studies For? Dominant Practices and Scalable Scholarship." *Engineering Studies* 1, no. 1 (2009): 55–76.

Fouad, Nadya, Mary Fitzpatrick, and Jane P. Liu. "Persistence of Women in Engineering Careers: A Qualitative Study of Current and Former Female Engineers." *Journal of Women and Minorities in Science and Engineering* 17, no. 1 (2011): 69–96.

Gerwitz, Christopher, and Marie Paretti. "Becoming After College: Agency and Structure in Transitions to Engineering Work." *Engineering Studies* 13, no. 2 (2021): 111–131.

Jesiek, Brent K., Aditya Johri, Cory Brozina, and Russell Korte. "Work in Progress: Novel Ethnographic Approaches for Investigating Engineering Practice." Paper presented at the American Society of Engineering Education Virtual Conference, 2020.

Jesiek, Brent K., Natascha T. Buswell, and Swetha Nittala. "Performing at the Boundaries: Narratives of Early Career Engineering Practice." *Engineering Studies* 13, no. 2 (2021): 86–110.

Johri, Aditya. "Learning to Demo: The Sociomateriality of Newcomer Participation in Engineering Research Practices." *Engineering Studies* 4, no. 3 (2011): 249–296.

Lutz, Benjamin, and Marie C. Paretti. "Exploring the Social and Cultural Dimensions of Learning for Recent Engineering Graduates During the School-to-Work Transition." *Engineering Studies* 13, no. 2 (2021): 132–157.

Rynes, Sara L. "Career Transitions from Engineering to Management: Are They Predictable Among Students?" *Journal of Vocational Behavior* 30, no. 2 (1987): 138–154.

Stevens, Reed, Aditya Johri, and Kevin O'Connor. "Professional Engineering Work." In *Cambridge Handbook of Engineering Education Research*, edited by Aditya Johri, and Barbara Olds, 199–137. Cambridge, UK: Cambridge University Press, 2014.

Samantha R. Brunhaver
The Polytechnic School, Arizona State University, Mesa, AZ
✉ sbrunhav@asu.edu

Brent K. Jesiek
School of Engineering Education, Purdue University, West Lafayette, IN

Russell F. Korte
Graduate School of Education and Human Development,
George Washington University, Washington, D.C.

Alexandra Coso Strong
College of Engineering and Computing,
Florida International University, Miami, FL