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BEYOND INCLUSION, BEYOND WELCOME: FRAMING INTERSECTIONAL RESEARCH IN ENGINEERING EDUCATION

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Executive Summary

With support from the National Science Foundation, we held a 1 ½ day working conference in the fall of 2016 that "brought to the table" scholars, practitioners, policy makers, and other thought leaders from diverse fields and backgrounds to frame new research possibilities regarding engineering participation by underserved communities. The *Who's Not at the Table?: Building Research Capacity for Underserved Communities in Engineering* conference attracted 70 educators, education researchers, and policy makers from around the country to Clemson University.

The resulting dialogue represented a groundbreaking opportunity for participants to contribute to creating a national agenda for research into broadening participation by persons self-identifying as those with disabilities; veterans; low income/first-generation college goers (LIFG); and persons of lesbian, gay, bisexual, transgender, intersex, or queer (LGBTQ+) identity. While not excluding inquiry into matters of race, ethnicity, and gender, we hoped to bring these severely understudied experiences among students, faculty, and employees in engineering fields into clearer and more sustained focus.

The conference itself was organized around five threads: theories, research methods, research questions, educational practices and experience, and knowledge needed to inform practice. A panel discussion, breakout sessions, structured and unstructured time for reflection, small group exercises, a poster session, and meals centered around discussions of these five questions. Throughout the event, participants documented their ideas and discussion points on sticky notes. Hundreds of sticky notes containing participants' ideas on these threads were generated over the course of the day and a half.

The project has several products to date, with more planned. The conference proceedings, and other products, are available at our Inclusive Engineering website (**www.inclusiveengineering.org**). We intentionally made intersectionality and inclusivity a focus of every aspect of planning the conference. An example of this focus is demonstrated in our recent national webinar hosted by the American Society for Engineering Education Minorities in Engineering Division and powered by the Women in Engineering ProActive Network. This webinar (available at www.wepan.org/page/aseemindhie and on our Inclusive Engineering website) presents specific ways to help individuals and organizations make events more inclusive.

The ideas generated at the conference—documented here —as well as the forthcoming research agenda operate at two registers. They enhance our ability to determine what improvements can be made to existing research strategies for broadening participation of groups who are often "*not at the table*" when it comes to broadening participation discussions—that is, those who are customarily excluded as subjects of engineering education study by structural inequities of the stratified economic and social systems in which people live, and by routine institutional practices at all levels that do not allow students and faculty of certain identities to join the table of engineering identity. Participants reflected on the role of engineering education research *itself* heretofore in perpetuating inequitable structures and deep questions about the changes and expansions in research settings and communities of practice that may lead to proportionate participation in engineering across all groups. In this sense of

expanding the community of engineering education researchers, too, addressing the question of "who is not at the table?" is crucial.

The representation of persons of minority identity in engineering, including the groups of particular concern to this project, remains disproportionate across all sub-disciplines in American engineering. While certain sub-fields display greater inequities than others, and different minority communities attain more and less proportionate participation in engineering, the overall pace of correction of this historic underrepresentation remains glacial. Programming in educational and policy settings intended to correct such inequities is continual but in many instances of small scale or ineffectual (Malcom & Malcom-Piqueux, 2013).

To reiterate: In an important sense, in asking "who is not at the table," the "table" itself is very much our subject, as participants investigate not simply the experiences of those absent from engineering but the characteristics of engineering thought, instruction, accreditation, and employment that may be reproducing social inequities. We feel that deficit models, which operate on the presumption that under-represented groups require reformulation or skill development prior to institutional participation, remain common (if unconscious) in engineering education and forestall effective address of inequitable conditions (Harry & Klingner, 2007; Slaton, 2010). Our aim with this conference, and in enlisting a wide ranging, multi-disciplinary research and practitioner constituency, was to interrogate familiar ideas of inclusion and exclusion in the context of institutional conducts, to question the social relations from which such demographic patterns and judgments about them derive.

Summary of Conference Threads

Thread 1: What Theories Inform Your Work?

A number of participants expressed anxiety and intimidation regarding the use of theory in their work. Theory was often characterized as a "scary space," and some participants questioned the appropriateness of applying existing theories commonly used in engineering education to studying the populations in question. The hesitancy regarding the use of existing theory was due to concerns that the assumptions underpinning them are often, at best, unstated, and at worst, function to (re)produce marginalization. In particular, critical theories were suggested as an alternative because they incorporate the historical context surrounding policy and practice; participants felt that critical theories offered powerful tools to challenge exclusionary practices in educational systems. Other participants emphasized theories related to identity, change, and learning. Some participants even took an anti-theory stance suggesting that work related to these populations should not be guided by theory, but instead new theories should be generated from the data.

Thread 2: What Research Methods Inform Your Work?

Participants cited the many ways that research data collection, analysis, and dissemination often work to further marginalize the communities of discussion. Participants identified proposal reviewers and funding agencies as forces driving research foci and methods by controlling what research is funded. Participants expressed concern that despite the growing need for research methods capable of capturing and reporting the experiences of marginalized persons within engineering, they observed a disproportionate preference among engineering education research communities and funding agencies towards large quantitative research studies. Participants questioned the appropriateness or ability of quantitative methods to capture the stories and voices of these populations; instead participants identified qualitative research methods as potentially being more appropriate to capture and understand marginalized experiences. Finally, participants emphasized the need for researchers themselves to critically examine their own assumptions and values underlying their work.

Thread 3: What Research Questions Inform Your Work?

Participants discussed the importance of exploring how institutional structures, policies, and practices affect visibility, recognition, and inclusion for individuals from different social groups. The participants also emphasized research questions that worked to create inclusive campus and engineering environments and utilized co-constructive methods. Finally, participants believe both researcher and practitioner knowledge should inform research questions in ways that break down normative culture to lessen barriers and marginalization of individuals from underrepresented groups.

Thread 4: What Educational Practices or Experiences Inform Your Work?

Participants discussed and highlighted institutional structures that act as barriers preventing students in these populations from participating fully; namely the policies and cultural norms of engineering education defining the very narrow range of identities that align with what/who an engineer is. The participants also emphasized that such institutional barriers can be reduced when institutions of higher education and

engineering departments make inclusion a priority and engage in diversity and inclusion efforts and by making classrooms accessible and incorporating these themes into the curriculum. Finally, participants called for a stronger path for research to inform practice and program development as well as research being informed by practice.

Thread 5: What Are the Things You Wish You Knew Better to Do Your Practice?

Participants were looking for guidance on how to create and sustain institutional change on all levels of education (i.e. K-12, college, as a researcher/practitioner, in one's professional practice). They also contemplated how to challenge the existing stigmas and norms within engineering to help shift the culture towards a more inclusive environment. In particular, participants wondered how to achieve buy-in and find out who could act as their partners and allies in these efforts; some participants characterized the work of challenging the system of engineering education as a treacherous journey for a new faculty member or researcher.

Introduction

In October of 2016, 70 educators, education researchers, and policy makers gathered at Clemson University to engage in unprecedented ways with the stubborn questions of how to increase diversity and inclusion in American engineering education. The unique character of this 1 ½ day NSF-funded meeting, entitled "Who's Not at the Table?" (WNATT), derived from two of its primary organizing premises. First, the event focused on the experiences of marginalized communities in the United States other than women and people of color, the subjects of much funded research on these issues. Instead, the experiences of LGBTQ+ individuals, veterans, LIFG, and persons with disabilities formed the center of our work together. In American efforts to understand how best to broaden participation in engineering (what is commonly called BPE research), these groups have remained relatively rare as the subjects of published work and institutional programming (Cech & Waidzunas, 2011). WNATT explicitly aimed to correct that underrepresentation in equity discourse and practice.

Second, building on an iterative set of exercises and discussions, the workshop was based firmly on reflection, as participants were asked to consider analytic theories, research methods, and research practices in tandem with their own institutional and intellectual positions. Attendees' senses of concern regarding BPE, their experiences of working within engineering or related institutions, and their experiences of living as community members with their own identities and ideas regarding identity, were integral topics of conversation at WNATT. The project's overall objective was to create a national research agenda for investigations of marginality in engineering, reaching well beyond familiar demographic framings and in so doing to find means of understanding the choices we have thus far made in our research. These inseparable priorities of observation and reflection, organizers believed, would together lay the groundwork for new and rigorous research initiatives on engineering diversity.

In addition to drawing in understudied social groups as research *subjects*, this project took a step back from established research *behaviors* in a number of respects. For one, the design of the workshop involved explicit framings of identity itself as a powerful force in American education and work; we sought to ask, in many different ways, how ascriptions of difference take shape and what such ascriptions might mean for engineering learning and labor. In other words, neither the fact of difference operating in American higher education today nor the consequences of that social circumstance were taken for granted (Ahmed, 2012; Berrey, 2015). At no point did the assembled scholars, many representing particular communities of professional interest as education researchers, social scientists, or service providers, fully equate the experiences of all the various groups under study; unquestionably LGBTQ+ people, veterans, LIFG, and individuals with disabilities have distinct experiences in higher education and in their working lives. The very existence of so-named groups, intended to demarcate communities from one another in American society, makes any wholesale conflation of such experiences ring false (Singh, 2004). Yet, the fact that identity still heavily determines an individual's opportunities and experiences well into the 21st century, when post-civil rights meritocratic ideologies have ostensibly produced a race- and gender-blind society in America, prompted organizers to see value in analytically unifying all categories of marginality at work in engineering.

The organizers of WNATT believe that the ways in which human difference has come to shape engineering learning and work in the nation, settings often described as free of social and ideological commitments based on identity, require attention if we are to solve the problems of inequity. Conceptions of gender, race, and ethnicity operating in American engineering functioned in this regard as important elements of our conversation, even if they were not our primary focus. Similarly, the routine identification of some engineers as members of majority groups was an important subject for WNATT; who remains unmarked—people seen to be male, White, heterosexual, abled, or native-born Americans—has a great deal to tell us about who is marked (Berrey, 2015). By articulating the *nature* of difference in U.S. engineering, as well as of particular experiences of particular differences, we sought to create a foundation for critical conversations on diversity research. The core belief that identities are not stable or singular in our culture is captured by intersectional analysis, a central tenet of WNATT that highlights the powerful role of time and place in our experiences of difference. Intersectional analysis reminds us that our understanding of selves and others as having a race, gender, sexuality, or as abled or disabled minds or bodies, derives from social conditions, not from unchanging innate characteristics of individuals (Grzanka, 2014).

Further, these conversations about difference in engineering education operated on several registers, as we sought to capture familiar practices and unconstrained visions for reshaping our BPE scholarship. To get a sense of the many approaches and methodologies currently used in diversity, we asked participants to share all the techniques they had used themselves or encountered in others' research. A remarkably diverse landscape of practice became clear: Picture a steadily growing set of notes—a great many sticky slips of paper, accumulating on larger pieces of paper, those in turn joined together to create whole walls full of ideas—representing dozens of quantitative and qualitative methods, research questions, and findings. Another focus for participants was the institutional, disciplinary and personal conditions that had made those their approaches and methodologies of choice: In other words, reflections on our research conducts as expressions of our disciplinary or job expectations (Riley, 2017). Finally, to enable visionary thinking about new research directions, we gave participants free rein to imagine "fantasy" projects, unlimited in budget, scope, and impacts. Over our time together writing, drawing, and speaking to one another; through closely structured exercises and freewheeling debates; around meeting tables and at fireside chats, WNATT attendees brought both new subjects and new perspectives to the issue of equity in engineering education.

Background

The dual goals of WNATT—to weigh established and emerging research approaches in light of inclusive BPE goals, and to enable reflection on researchers' positions as community members—led to the event's use of five "threads":

- Thread 1: What Theories Inform Your Work?
- Thread 2: What Research Methods Inform Your Work?
- Thread 3: What Research Questions Inform Your Work?
- Thread 4: What Educational Practices or Experiences Inform Your Work?
- Thread 5: What Are the Things You Wish You Knew Better to Do Your Practice?

Each participant committed to work for some portions of the meeting as a group member focused on a single thread, with other elements of WNATT involving reporting out to the entire workshop, critical responses shared among the threads, and other collective tasks across all five groups. In framing distinct threads, the organizers aimed to cover heterogeneous aspects of engineering education research on inclusion. Overlap among the groups in terms of conversation or findings was expected and not seen to be a problem because the organizers wanted to empower participants to immerse themselves either in familiar or unfamiliar heuristics as they so chose. The five threads were intended to bring out familiar features of our research, and also allow for discussion of both new approaches and incompatible priorities. The general findings of each thread are included in the Summary of Conference Threads and discussed at length below in the body of this report. Here, we provide a sense of why the organizers felt these particular threads promised a generative set of conversations:

Theory as Opportunity, Pressure, and Risk: Thread 1

Although theories of learning, identity, and economic participation formed a portion of many discussions across WNATT, "Thread 1" brought the idea of theory to the forefront for participants. Crucially, explicating the value of educational and social theory for engineering equity was not our only objective. While we sought to empower critical qualitative analysis and ensure rigorous theoretical debate in research, our aim was to make both the excitement and trepidation researchers experience when encountering theory into valid topics of conversation. This was in keeping with our dual goal of both producing a new research agenda and encouraging reflection on the conditions of BPE research.

The intellectual advantages and risks of concerted theoretical engagement were on our minds as we shaped this thread. Without the possibility of high-level abstract analysis such as theory allows, the ways in which identity emerges and persists in society cannot be well understood. For example, "intersectionality theory" supports a complex picture of identity ascriptions over time, under distinct political and social circumstances. Theories of actor agency, or how people learn, or how organizations function also support such nuanced overviews. At the same time, we were aware that theory can be esoteric or intimidating. It can discourage the contributions of empirical researchers or newcomers. Not least important, because all theory is political, uptake of more conservative theories can constrain reform.

For all of these reasons we developed a thread focused on theory, and as discussed below, participants shared a great many impressions that confirmed the value of such a direct address.

Framing the Problem Through Our Questions and Methods: Threads 2 and 3

In Threads 2 and 3, participants were asked to assemble examples of the framing concepts used in their BPE scholarship; that is, their research questions and methods. For participants active primarily in diversity, veteran, or disabilities services who might not themselves conduct research, we wanted to provide the chance to share ideas on the nature of research they found most or least helpful. Overall, in creating these two threads, WNATT organizers hoped to shed light on what has constituted legible, credible, and inclusive problems in engineering programs, and what methods have prevailed as optimal means of studying those problems, respectively.

With a stress on intersectionality being one general goal for the meeting, we also hoped that these two threads would bring out any narrowness currently shaping BPE research and some new ideas for flexible, more layered approaches to identity. In configuring Thread 2, focused on research methods, we hoped to bring out the differences between qualitative and quantitative research and explore benefits of both approaches for BPE investigations. Typically in engineering education research, the use of quantitative methods and studies centered on large rather than small bodies of data tend to receive praise and funding. The organizers sought to support creative thinking about qualitative methods and mixed methods for the study of BPE; both approaches seem like ways to bring strong questions regarding taxonomies of difference (race, gender, cognitive or physical disability, sexuality, etc.) and the structure of data sets.

In turn, Thread 3 provided an opportunity for powerful reflection on the problems that seem to be in need of attention when the study of identity and equity arise in engineering. What questions customarily hold the attention of researchers, and why? What gets funded, and why? Here we hoped to incite conversation not simply about what has or might merit attention in equity research, but about whose voices and perspectives are and are not being brought to BPE research questions. For those WNATT participants less interested in research methods per se, including possibly those from teaching and service backgrounds, Thread 3 offered a chance to think about the parallel issue of what has and might matter in engineering education research.

Living Research: Threads 4 and 5

The organizers of WNATT created two threads expressly for participants who might be eager to reflect directly on their own experiences of conducting BPE research. By drawing our attention to practices and experiences encountered in doing research, we hoped that Thread 4 would allow researchers to bring issues of their own institutional positions, resources, and identities into the discussion. Thread 4 was meant to be distinct in this sense from Threads 2 and 3, which focused on established or potential research conducts. The emphasis on “practices and experiences” seemed likely to invoke a much wider array of conditions in which BPE investigations come to be. Closely related, Thread 5 might bring attendees’ focus to skill gaps, missing resources, and not-yet-imagined research subjects and techniques.

Like Thread 4, Thread 5 was intended to enable deep reflection on personal experiences within the engineering academy and certainly the organizers believed strongly that these need not be positive or constructive experiences. In much of the published literature surrounding engineering education and

diversity research, best practices are proposed and tested in accordance with standards of rigorous social scientific investigation. WNATT supported those standards, but also encouraged uncertainty, including regarding the necessity for change. Thread 5 represented for the organizers the possibility that the very premises of the workshop might themselves come under scrutiny, from either procedural or political vantage points. We felt that WNATT, an academic enterprise funded by established entities, should not proceed as if we were separate from the institutions and standards we sought to critique.

Importantly, while enabling uncertainty and shared expressions of frustration, Thread 5 was also intended to lay the groundwork for wish-lists and other fantastic thought experiments in which the whole workshop would ultimately participate. That culminating exercise brought humor, verve, and incredible creativity to the summative portion of the event. To provide a space in which anxiety, frustration, and enthusiasm might all be welcome was a primary goal of WNATT, and that openness resulted in a remarkably constructive meeting with unexpected and significant findings.

Summary of Thread Discussions

Thread 1: What Theories Inform Your Work?

Participants expressed a range of experience, comfort, and levels of support related to the use of theory in research and practice related to broadening participation in engineering. The amount of experience articulated ranged from extensive experience utilizing theory to inform or interpret research findings, to having some experience using particular frameworks, to participants who shared that they had never intentionally used theoretical frameworks to guide their practice and were unsure of where to begin. A wide range in levels of support for using theory was also articulated by the participants. Reflected in the participants' sticky notes and conversations was a range of opinions about the appropriateness of utilizing theory, the limitations inherent to using existing theories (are existing theories capable of accurately and fully capturing the experiences of these populations, or do they work to reproduce cultural norms?), how theories might be made accessible to a wider audience, and the ways researchers may develop new theories to guide work related to broadening participation in engineering.

The authors note that throughout the group work on this thread, the notion of what constituted "theory" as a topic for group conversation itself shifted. For some participants the word "theory" pointed to various explanatory frameworks meant to be predictive or summative of observed phenomena in engineering education settings. For others, it pointed to hypothetical ("theoretical") points or narratives generated by those studying engineering education or to abstractions only indirectly related to observations. Central to the conversations, it appears, were different ideas about theory held by participants in the social sciences and those in engineering or science fields. Potentially, activities that introduce each of the two groups to the general nature and role of theorizing in the other would be productive.

As well, the group working on this thread, perhaps due to the collaborative nature of the project, often referred to theory as a general category of intellectual engagement for researchers rather than to specific theories of educational, developmental, or political conduct. Crucially, many individual participants see theoretical engagements as potentially both supportive and limiting to the goals of BPE research, depending on how that engagement is undertaken. Despite these loose and varied ideas about what would count as the "theory" or "theories" under discussion, the thread addressed many identifiable opportunities and pressures around the use of theory. The summaries below reflect these multiple concerns among participants, which produced suggestive, if not entirely integrated, observations on conducting BPE research.

Role of theory

Participants questioned what the role and purpose of theory is, and should be, in engineering education research and practice related to broadening participation. Some participants felt that a stress on theory may lead to unproductive abstraction or over-specialized research and analysis (see below on the "Limits of Theory"). Possibly this concern derives from the distinct roles often played by theory in social science and engineering, with participants from engineering accustomed to purely abstracted engagements with theory, remote from application. Others, however, suggested various ways in which theory could be productive in BPE research. One definition offered was that theories are a lens through which another's

experience may be understood, and theory may offer valuable insight into the experiences of persons belonging to these populations—if appropriate theories are applied.

If selected carefully and applied thoughtfully, appropriate theories can be powerful tools to understand and empower students, faculty, researchers, and practitioners to challenge assumptions underlying social structures and to design more effective teaching and learning interactions. Many participants emphasized that theories most appropriate to (and even capable of) fully capturing and understanding the experiences of persons of underrepresented and marginalized identities are those that incorporate historical contexts and perspectives. Participants also cautioned that many existing theories may have been developed in the context of deeply rooted (and at times invisible) social norms, and thus some theories may work to silently reproduce traditional social norms in research. Some participants suggest that when treated as a starting point of a research investigation, rather than a rigid guide, utilizing existing theory can be a powerful tool in research and practice. Among the implications of engaging explicitly with theory, researchers may find that they

- recognize broad patterns across social conditions or political episodes;
- articulate unexpected causal factors in observed phenomena; and
- reflect deeply on their own selection and evaluation of evidence, especially as those actions may be shaped by presumptions about a study's subjects.

As discussed below, some participants stressed that in the actual conduct of research, practice can never proceed without reference to theory and theory can never take shape without reference to practice, further justifying rigorous and explicit engagement with matters of theory. However, participants also felt that following an existing theory should not be the only measuring stick of rigor in research, as some studies are not appropriately guided by existing or dominant theories.

It would also be productive to consider other subjects of theorization alongside "identity" and "diversity" in STEM. For example, recent social scientific and educational research on STEM participation has foregrounded prevailing standards for engineering knowledge as a source of certainty, credibility, and social advantage for majority actors in higher technical education and labor. The absence of certain communities from these sites, by extension, can be studied as an expression of these intertwined values. What does and does not count as valid technical thinking or activity in any given setting is inseparable from matters of identity and the two conceptions should be studied in tandem.

Goals of theory outcomes

Participants also highlighted the importance of BPE researchers carefully considering the numerous outcome goals with which one may enter a study so that decisions related to theory selection, application, or development may be made with intention. Some concern was expressed that theory that heavily influences the structure of a study or interpretation of observed phenomena can stand in the way of *authentic recognition* of subject (and we might add, researcher) experience. (Discussion of larger institutional and social conditions in which theory takes shape, described below, expand on this concern.)

One message from participants along these lines was that *honoring difference should be learned by all stakeholders*: the individual researcher, the research and practice community, funding agencies, students, and by the field of engineering. The authors wish to offer encouragement to readers who may face challenges in supporting non-traditional and marginalized populations within engineering;

participants shared many stories of personal challenges faced in their efforts to identify theories that authentically recognize and capture the unique qualities of one's experience and that work to honor and celebrate these differences.

Participants also wished generally to challenge the research community to carefully consider how research (and the theoretical choices the researcher makes) can respect the agency of the members of these populations. Questioning the relationship between study subject agency and research, participants asked, how can research and its outcomes be done to empower these populations? Specifically, some wondered can studying up (those with less privilege investigating populations of higher privilege) or studying across (studying others of similar levels of privilege/marginalization) be an empowering path for both researchers and recipients of the research? Finally, participants emphasized the need to identify ethical principles appropriate to working with these populations and share these best practices with the research community and practitioners who translate research outcomes to practice.

In addition to considering honoring differences in the research subject, the participants also emphasized the need to honor difference in engineers by considering what constitutes the current socially constructed definition of an engineering identity—who does it include and who is excluded? One key theoretical space identified by participants as essential to consider is research around identity. Calls were made to redefine and expand the definition of what/who an engineer is to include the marginalized identities assumed by underrepresented persons. This includes calls to label and characterize normative identity dimensions such that they are no longer treated as assumed identity baselines (see notes on intersectional and other analytic approaches, below). One way to begin shifting the definition of who is recognized as an engineer may be accomplished through authentic inclusion in the research process where researchers may treat research subjects as experts in their experiences—which include experiences as an authentic engineer. However, researchers must be cognizant of how to include persons from marginalized communities without creating additional burdens on already overly-burdened communities. Finally, in challenging who an engineer is and what engineers do, a lack of research surrounding engineering's relationship to non-governmental organizations was identified; how could engineers contribute to such efforts? And, how can engineering contribute to creating inclusive engineering programs?

Limitations of theory

While explicit engagement with theory may offer valuable insight and guidance to collecting data and understanding findings in research, participants identified several challenges and limitations of theory ranging from challenges people face utilizing and comprehending theory, to concerns about the ability of theory to accurately capture rich non-normative stories, to opposition to the application of theory to this interventionist type of work entirely.

One challenge related to theory that echoed throughout the event was the perspective among participants that the so-named theoretical space was intimidating; participants expressed anxiety or uneasiness, calling theory "a scary place." Intimidation related to theory, especially with regards to identifying an appropriate theory when one is not intimately familiar with the vast array of theories available, cannot be ignored. This intimidation is especially problematic when one considers the opportunities potentially missed in the research-practice relationship. Although we cannot verify the level (new researcher, established researcher practitioner, etc.) of the person who voiced these perceptions of uneasiness, it is not difficult to imagine how an individual not trained as a professional researcher might shy away from engaging in the theoretical space to use theory to inform practice. If comprehending theory requires an

elite skill set and training, how can researchers hope to have their findings widely adopted or taken up by influential actors?

It became clear that participants find power implications in the use of theory and in the choice of specific theoretical approaches. Different expressions of concern over power dynamics related to personal and professional identity were shared related to both expectations and risk-taking. Referring to a video of a person attempting to learn how to operate a bicycle with the handlebar navigation direction reversed shown during the event, one participant felt that elevated patron/audience expectations created a pressurizing situation for researchers, stating that "you're expected to ride both bikes every day just as well as single-bike people and the bike randomly switches on you and sometimes you're supposed to ride both at once." Participants also expressed frustration with the basic expectation that research must be guided by theory. Some participants thought theory served as a barrier to professional attainment, articulating not only feelings of anxiety surrounding the adoption of an unfamiliar framework into their work, but the perception that theoretical knowledge has been given priority over experiential knowledge of practitioners, students, and researchers.

While some participants spoke of the impossibility of segregating the influence of theory (i.e., framing conceptualizations) and practice (i.e., experience) on the conduct of research (see below), the social dynamics inhering in all educational research work were widely acknowledged by the group. Some participants wondered if work related to social justice and broadening participation is held to a higher standard than other types of social research. Additionally, participants explained that relative comfort and safety to challenge theory is reserved for those further in their career, in that scholars with tenure are willing to take risks and depart from traditional theories, but junior scholars *cannot* dismiss their fields' norms and expectations without significant professional consequence.

Another concern emphasized by participants is an apprehension about using existing theories as well as concerns over creating new theories in the current social context. Participants questioned existing theories' ability to capture the realities of these populations, citing the tendency for existing theories to impede social change by (re)creating and reinforcing normative values and perspectives. Certain families of theory, for example those following positivist perspectives, risk missing—or worse, silencing—the experiences of persons with non-normative identities and perspectives. While some participants supported the use of theory in this work, others challenged the necessity and appropriateness of theory, standing firmly in opposition to using existing theory to inform work on marginalized populations. They noted that all theories are limited to some extent, or flawed as a reflection of empirical conditions, and all are value-based—they reproduce normative perspectives and can be exclusionary, acting as a barrier to social change. Some raised the question of whether using theory is even necessary in research with these populations, presumably because these participants see BPE issues as addressable with "purely" empirical studies.

They also pointed to power structures acting as gatekeepers that control theory development (i.e. funding agencies controlling the types of work funded and reviewers preferring or expecting the application of established theories). Some said that there exists a false dichotomy where they observed that utilizing a theory was necessary to have their work selected for funding yet they expressed opinions that many (if not most or all) existing theories are not appropriate for fully capturing the rich and non-normative experiences of the populations discussed, referring to theory as a gatekeeping mechanism that works to recreate the dominant set of values. This concern ties directly to the need for reflexivity and to critically

assess one's own motivations to select a specific theory to guide a research study (which is discussed in detail in Thread 2).

Developing new theories

To address concerns over the limitations of using existing theories, many participants recommended that new culturally inclusive theories be carefully developed that may better capture the experiences of these populations. Participants emphasized that all theories are value-laden conceptual projects developed within a social, political, and worldview context.

A significant challenge participants identified related to theory development is that there are larger power structures controlling the development of theory, including funding agencies, universities, and the field of educational research as a whole. Researchers, especially those young in their career stage, all must work within the expectations of their more established counterparts. In terms of funding and tenure decisions, university leaders wield the power to control the encouragement or suppression of conversations about agency, challenging power structures locally and nationally, and promoting and rewarding or punishing and preventing risk taking. Faculty wishing to challenge the adoption of established theory are required to take significant professional risks and face challenges in funding and publishing.

Many participants emphasized that the development of new theories can empower social change, and point to adopting a critical perspective as an absolute necessity in the development of theories more appropriate to capturing and understanding the experiences of persons from these marginalized populations. Specifically, they highlight the need to develop new theories to critically assess (and challenge) numerous value-laden assumptions underlying existing theories. Researchers and practitioners can reflect on the values underlying theories by critically challenging their conception and application by considering questions such as *Who is the population this theory was designed for? Who was in the sample from which the theory was designed and tested? Who decides which theory is appropriate to guide a study—is it the researcher or the research/funding community?* and, *How might this theory be limited or biased?* These questions suggest broader or deeper ones as well, such as, from what established research traditions, political ideologies, or disciplinary conventions do individual theories derive?

To name and challenge the norms underlying theory, participants explained that researchers must first contextualize engineering as a field (i.e. acknowledge the historical, industrial, military-influenced context of the conception and evolution of engineering as we know it today) as well as the social, political, and ideological contexts that underpin existing and developing theories—especially those that contribute to exclusionary practices in engineering education. Exploration of context is essential to promoting inclusion. As one participant put it, "without historical context, we cannot actually understand how to promote inclusivity or even how to determine when a meaningful inclusion is achieved." Through examining these contexts and influencing factors we can begin to challenge and expand upon existing theories to consider new formal and informal contexts not yet explored.

Participants also emphasized that researchers can use such work to challenge static conceptions of knowledge, explaining that, "we should consider was that our conceptualization of research and knowledge production causes problems for yielding real-world impact. Abstraction and presumed

objectivity can pressure us to fail to ground our work in the actual realities of marginalization and producing change."

Some existing theories identified as being more appropriate for studies of marginalized communities focus on critical theories (race, feminist, tribal, etc.) that challenge systems of higher education, as well as identity theories that focus on dimensions of personal and professional identity, and pedagogical theories related to teaching/learning. Furthermore, calls to incorporate an intersectional perspective into engineering culture were made—understanding an engineer as a fluid, context-specific interaction of many identities rather than in a singular dimension may help researchers and practitioners to better understand how and why current teaching/learning and engineering identity development and socialization approaches may resonate differently with all students and engineers, not only those who bring marginalized identities and non-traditional backgrounds to their engineering practice. Intersectionality may also be adopted as an analytical disposition rather than just as a theoretical perspective that can support open inquiry about another's experiences and encounters with power. Participants also identified change and motivational theories as well as culturally relevant pedagogy theories as being highly relevant and valuable to this kind of work.

Critical theories such as these have been used extensively in other fields and may prove to be powerful tools in understanding diverse populations of engineers. Researchers and practitioners can learn from other fields about theories and inclusive practices to widen the array of theories that are not currently typically adopted in engineering education research and practice, as well consider new methods for putting such inclusive theories into practice (e.g. using social networks to build communities to support for marginalized groups).

Finally, participants spoke about the exclusionary nature of theory regarding teaching and learning of technical knowledge in that such theory currently does not fully incorporate the rich knowledge and theoretical insight developed within the K-12 space. Participants emphasized that K-12 work must inform higher education theory development and application to form more complete and robust understandings of how engineers develop, and doing so can combat the de facto exclusionary nature of higher education research.

Connecting theory and practice

The greatest missed opportunity identified related to theory was the weak or missing analytical bridge between theory and practice. Participants made calls to disrupt the falsely constructed theory-praxis dichotomy, explaining that "there is no practice that is not informed by theory (whether consensus explicit or not) and no theory that does not implicate or enact a practice. It is a false dichotomy." Furthermore, participants explained that understandings of both theory and practice are weakened when the other is not attended to.

Sociologists of scientific knowledge and historians of education research suggest that the formulation of theories and the detection of evidence do not exist in a linear relationship: neither invariably precedes the other, and any given study may derive from the two operations occurring in any order. Participants in this thread echoed that view. However, participants also offered the possibility that increased awareness of the stages or features of research (including evidence gathering, theoretical work, or the application of findings) should be approached critically. For example, theory must be informed by practice and be made

useful to practitioners concerned with effectual instruction, resource use, and social justice. Bridging the social-technical divide common in engineering, cultivating social skills in engineering, pedagogical choices, recruitment/retention programs, engineering curriculum development, and educational spaces from the K-12 level to higher education and teaching should be informed by inclusive theories and incorporate or be guided by models of best practice.

To make theory useful, participants suggested using existing theoretical and practice models as a starting point to explore contexts underlying marginalization and change (i.e. cycle of oppression and cycle of socialization models) to inform new theory development. Also, they recommend incorporating many stakeholders (including users/informers of research, practitioners, research participants, learners, students, policy makers, and educational leaders) into the research process, particularly in the identification of research questions, to more effectively identify needs and to bridge theory development to research to practice.

Making theory accessible

There was a shared perception among participants that the difficulties of active engagement with theory represent a real and significant barrier for many researchers and practitioners. This suggests that allowing others to more easily identify, understand, and incorporate theory into engineering programs and curriculum development will only strengthen engineering education. Strengthening relationships between researchers and practitioners, making this bridge between theory and practice stronger, incorporating more diverse thinking and backgrounds into new theory development, reducing feelings of intimidation, and removing theory incorporation as a barrier all require theory to be made more accessible.

How can researchers make existing and newly developed theories accessible? Not only to locate, but to more easily make actionable for practitioners, and to strengthen the bridge (and ideally the feedback loop) between theory and practice? Participants wondered how to help researchers and practitioners, especially those new to studying the experiences of marginalized communities, to identify and employ theories verified to be appropriate for fully capturing and incorporating the experiences of these populations into their understanding and educational choices, or otherwise empower them to challenge existing theories? How can intimidation related to theory be diminished? How could results be shared in ways that non-researchers may easily locate and incorporate them (i.e. not publishing in journals designed for the research community)?

Perhaps one solution is to establish more communities of researchers and practitioners who either currently do this type of work or who are interested in entering this evolving engineering education frontier. Participants suggested the formation of communities of practice designed to help those interested in supporting persons from these populations to educate themselves, receive support for and guidance in their work, to share results in a more accessible way, and support authentic inclusion and equitable practices inside and outside of engineering classrooms.

There is a powerful set of arguments made by recent theorists in the fields of gender, queer, disabilities, and subaltern studies regarding the cultural meanings of identities and how these may instantiate privilege and marginality. Cultural, linguistic, sociological, economic, geopolitical, aesthetic, and other methods inform such scholarship to produce theories that often transgress familiar elite framings of identity. For example, the idea of singular and permanent identities, functioning irrespective of setting,

has been set aside by those who see identities as shaped by social relations. Scholars of education, labor, and other sectors have taken up these theories, a development which suggests that the abstractions, patterns, and broadly applicable causal explanations that the theories offer can support equitable scholarship such as that many BPE scholars hope to undertake.

Such theories also articulate incisive means of reflecting on how researchers and subjects are co-produced by analytical practices (and the cultural institutions that endorse such practices). Here, the power relations of human-science research is highlighted and examined. Fields such as anthropology, social justice, and critical development and human resources studies have all laid out theoretical framings in support of more egalitarian social relations, often using particularly reflective techniques. Having engineers and STEM education or diversity research convene with such scholars, as well as with members of marginalized communities, would create a rich opportunity for exchange. Such exchanges could help decenter the idea of a singular engineering expertise, or conventional ideas of rigor that have perpetuated inequities in engineering education despite well-intentioned inclusive programming. This kind of gathering could dovetail well with that mentioned above: Having social science (or humanities) and engineering (or science) practitioners share in a generous and systematic way ideas about how theory usually works within their own sector.

In all of these proposed engagements, presumptions about what a field, or individual expert, knows about others (students, employees, colleagues) are placed in a strong raking light. The idea that a particular approach to education or educational reform is best can come to be seen as serving the interests of the observer, and those interests can be reflected upon. In short, the aim of "walking with" research subjects, rather than "studying" them is supported by this theoretical inquiry. Possibly if those excited and engaged by theory in BPE research, and those (both researchers or community members remote or intimidated by theory), begin a conversation with such shared, equitable goals, the potential of so-named theory to enrich inclusive BPE research might be made evident.

Thread 2: What Methodologies and Methods Inform Your Work?

Systemic influence of funding agencies and reviewers

Reviewers and funding agencies continue to drive research foci, forms, and methods by controlling what research is funded and widely disseminated. There exists a disproportionate preference among engineering education research communities and funding agencies to value, support, and reward large quantitative research studies, despite the growing need for research methods capable of capturing and reporting the experiences of marginalized persons within engineering (including those self-identifying as LGBTQ+, veterans, LIFG students, and as having disabilities). There is a need for new and innovative methodologies, methods, and forms of dissemination to demonstrate the value of research exploring the perspectives of underrepresented students. A cultural shift is necessary for small sample size studies to be deemed as "impactful" (i.e. hold as much value and presence) as large sample size studies. Similarly, the general preference for quantitative rather than qualitative research might be interrogated.

Finally, funding agencies must provide proper resources to capture underrepresented voices because funding criteria designed with needs of "normative" participants in mind is insufficient for exploring the

lived experiences of “non-normative” participants. For example, this might include funding to provide American Sign Language interpreters to participants, or travel to remote areas where participants live.

Researcher lens, worldview, and positionality

Educational research that explores the experiences of underrepresented groups requires researchers to consider their place and relation to systems of power, privilege, and oppression. Critical examination of the influence of these systems and their relation to our social identities and background are connected to opportunity, access, and experience; this critical examination establishes reflexivity and researcher understanding of positionality. This critical awareness is necessary to more fully understand underrepresented populations’ experiences and how social systems influence the ways in which we the researchers and those we study are socialized (critical consciousness) and how systems of power, privilege, and oppression are (re)produced within engineering education.

There is likely much research outside of engineering education that can offer valuable insights to inform this work. Particularly, critical theory and intersectionality have been widely used in other disciplines but studies guided by these perspectives are not nearly as ubiquitous within engineering education. Within engineering education, there is a need to be open and transparent about the researcher’s positionality and worldview with respect to the research and the participants. Currently, marginalized stories are told within the context of and in relationship to the dominant narrative but not vice versa. For example, stories of LGBTQ+ individuals are described and labeled in relation to heteronormative contexts but the converse is not true—in fact, normative identity dimensions are rarely even given labels and simply stand as the benchmark against which others are compared.

Research should be interdisciplinary, pulling from different domains in ways that inform researcher lenses and methodological choices to be more reflexive, empowering, and representative of marginalized voices and experiences. Researcher lens and critical awareness/positionality are interconnected to methodology, choices of methods, and dissemination of findings. How we as researchers see the world, and the areas of scholarship we use to frame our research, affects the way we do research, and what we find; these are inseparable aspects of research and both have profound implications for the communities and institutions involved.

Methodological choices

Methodological choice should be reflective and empowering of the populations we study. In practicing reflexivity and critical awareness, researchers should consider and be aware of how the population(s) we study are included/excluded based on our methodological choices. Methodologies (as well as theories and methods) are not impervious to discriminatory biases. A careful and mindful examination of the values, social and historical contexts, and assumptions underlying any methodology should precede a researcher’s adoption of a particular methodology as these silent values influence the type and ways data are collected and understood. In fact, failure to do so runs the risk of further marginalizing non-normative experiences, perceptions, and identities within engineering. This is particularly worrisome if current methodologies act to prohibit redefinition of what engineering education research is necessary and valuable, or the recognition of new and emerging identities that are marginalized and fall outside of the norm in engineering. Researchers must ask themselves questions such as “How do my chosen methodologies (and associated theory and methods) act as mechanisms of (re)production for privilege, power, and oppression?” and “Do selected methodologies have the potential to uncover and celebrate

new perspectives, or do they (re)create value systems within research and practice that are not inclusive?"

Finally, the importance of working with members of marginalized populations to fully capture and understand their reality rather than conducting research on them cannot be overstated; to empower, validate, and give voice to marginalized experiences within engineering, co-construction of understanding and meaning should be practiced with participants.

Research methods

Methods must be appropriate for representing and empowering voices and stories from marginalized populations. Additionally, research methodologies, methods, theory, and researchers themselves must be prepared to handle and embrace the "messiness" of research on the human experience. Qualitative methods can provide tools for understanding marginalized experiences as they embrace the subjective experience, which facilitates the emergence of rich and powerful stories that may counter dominant narratives about engineers and engineering. Qualitative research methodologies are currently seen as an appropriate approach to studying marginalized populations as they are designed to capture and analyze the complex ways marginalized individuals' multiple dimensions of identity intersect and interact with their educational experiences within engineering. However, there is a need for the research community to view qualitative research as legitimate, mainstream, and valuable in the same way quantitative research has historically been viewed in this field. Many researchers actually recognize the benefits of qualitative methods; however some hesitate to adopt qualitative approaches, as they perceive that doing so may threaten their professional advancement.

Researchers questioned the appropriateness of quantitative methods, and debated if quantitative methods were capable of capturing the stories and voices of marginalized populations. In this vein, the belief emerged among participants that that quantitative methods can potentially act to further marginalize already underrepresented voices. The familiar means of deployment of these methods might be reconsidered in light of the recognized benefits of qualitative research for capturing the experiences of marginalized communities. Researchers find themselves wondering how a quantitative perspective might help to inform and frame qualitative research, and how quantitative methods may be employed to explore these populations without losing the nuances of the marginalized experiences. Researchers may consider adopting mixed methods approaches that incorporate multiple methods and perspectives to leverage the strengths of both types of research but are cautioned to consider the implications and limitations of using mixed methods to study marginalized populations (i.e. if using quantitative methods is considered to be inappropriate to study these populations, is using mixed methods then inappropriate for the same reasons?).

There is no theory or methodology that is a one-size-fits-all for the unique voices from marginalized populations. New research methods should be created to specifically explore the unique voices and experiences of individuals from marginalized populations. Existing methods should be improved to do the same. Researchers should not shy away from exploring and adopting nontraditional and emerging methods, as they may provide different or novel ways of understanding marginalized experiences.

Research outcomes and consequences

There is a need to enhance quality in both conducting and disseminating engineering education research in terms of transparency of researcher motivation and positionality in publications, as well as to exert greater efforts in communicating the value and quality considerations associated with small, qualitative studies to stakeholders. Research in this area needs to be made available, applicable, and accessible to all (practitioners, students, researchers, etc.) through existing and new dissemination channels. Researchers and practitioners are encouraged to forge partnerships, as some see the link bridging research and practice as incomplete or missing. The application of theoretically-based research to inform interventions and programs in practice is essential, and researchers and practitioners should provide models for applications of research to practice through detailed accounts of implementation.

Building data sets

The very nature of quantitative research tends to erase voices of those who are marginalized. Existing data sets disproportionately capture expressions of the dominant culture and work to reinforce marginalization of the marginalized. Thus, quantitative research using existing data sets is ill-suited for examining the experiences of these populations. Yet, the absence of large quantitative studies capturing the experiences of those self-identifying as LGBTQ+, veteran, LIFG, or having disabilities points to a clear need to continue conversations about the relationship between quantitative research and underrepresented populations. A proposed outcome of work with these populations is the creation of national multi-institutional data sets centered on those self-identifying as LGBTQ+, veteran, LIFG, or having disabilities for use in future studies.

Thread 3: What Research Questions Inform Your Work?

The nature of research questions that occupy participants is extremely wide. It is important first to recognize that a single list of these questions cannot capture the following conditions:

- Participants listed research questions of narrower scale, say, on the nature of programming or engineering norms, and others that are much broader, about cultural inclinations or our ability as experts to self-critique.
- There are research questions that participants find susceptible to conventional investigative methods, such as survey or ethnographic techniques, and others for which participants believe they do not yet have methods.
- Some participant questions fit well together, while others created strong contradictions in aim and scope.

All of these tensions and internal contradictions are central to expanding the effectiveness of STEM education research and the instruments used to gauge that effectiveness. For these reasons, we have divided the content of this thread, as generated by workshop participants, into a description of the participants' general orientation towards research and listings of their research questions, themselves then into several sub-sections reflecting distinct research concerns. Bear in mind that we do not find any of these orientations to be more important than any other. Reconciliation among participants' research priorities and methods may not be possible and is not our aim.

Participants' general orientation

It is important to emphasize that participants wondered broadly about concerns **reflected in other threads** (rather than imagining "research questions" as a narrowly scientific matter), such as

- the messiness and discomfort associated with research and practice in this area, on the part of researchers and subjects;
- that there is not a one-size-fits-all model to capture the experiences of marginalized persons (it is a complex and multi-variant subject area);
- whether the audit culture acts as a barrier to the translation of research to practice; and
- how to ensure that research methods are accessible (e.g., data collection surveys for participants with disabilities) and do not work to erase marginalized experiences (i.e. calls to disaggregate research data).

They also spoke about the relational character of this research, including:

- How best to ensure that developed/recommended practices take into consideration the concerns of persons with disabilities.
- Emphasizing the importance of empathy, humanism, and humility in research as well as the necessity of conducting research *with* persons with marginalized identities rather than on them.
- The necessity of engaging persons outside of research into the research process (e.g., practitioners, users of research) and awareness of institutional and social structural conditions of research.

Additionally, participants reflected on the relationship of research and practice, first recommending that the so-called "research triangle" consisting of research questions, theory, and methods could be strengthened by adding the dimension of practice context to increase the likelihood that findings will lead to true change. In this thread, participants echoed concerns of other threads that sustained cultural change with "disruption at the ground level" should be an outcome goal of research rather than simply theorizing practice. Participants wondered what the process of translation of research to practice is and could be, then pointed to some considerations they see in this research-practice bridge:

- What can be brought in from other communities to our research?
- Are we asking the practitioners to assist in developing the research questions?
- Are we asking the right questions? (With respect to practitioner/implementation.)
- What are we training people for?
    - It is commonly believed that many underrepresented students want to study problems relevant to their lived experience.
        - Is this an accurate perception?
        - If students do wish to study such problems, how can we expand what engineering and science study is and what topics they take on?
    - Can these questions about the nature of engineering and STEM point us to profound rethinking of what counts as engineering rigor, and who counts as a talented student or engineer?

Participants' research questions

Participants identified what they referred to as **meta research questions,** which address concerns related to the (re)production of values through research. Included in this are questions related to reinforcement of norms, expanding conceptions, definitions, and measures, and ways to acknowledge limitations of research. The following questions were taken verbatim from participants' ideas captured on sticky notes:

- How do our questions reinforce our cultures and the actions we are trying to change?
- What are the norms of particular research communities?
- How do research methods' inherent biases skew the funding or exclude individuals? (e.g. self-selection out of STEM.)
- How do we explode or loosen the grip of our own structured categories, definitions of research, "appropriate" methods, theories, questions, and the like.?
- How do we know when we are doing research? Doing it well?
- How can we normalize alternative approaches?

On the challenge of "identity" as a working category of STEM diversity research:

- What questions about the analytical role of "identity" should we be posing?
    - Why are we so stuck on identity binaries, instead of continuums?
    - Why focus on identity at all, rather than on, say, experience?
    - If there are no legible identities, does our work cease to appear as research?
    - We use proxies for social class; how can we understand this better?.
- How do we unlearn learned research behaviors?
- How can we normalize diversity without creating new modes of exclusion?
- How do you change a bias that you don't realize exists? (Including biases related to age and experience level.)
- What is the role of vicarious experiences in engineering education research on an underrepresented population (when the researcher is not a part of the population)?

Additionally, many pointed to the role of **culture** as necessary for the critical study of STEM diversity:

- What are the "bullshit excuses" that limit the impact of research and research-derived STEM programming?
    - What are accountability structures (accountability service/accountability anonymous) and how do these support such excuses?
    - What conducts, such as the crowdsourcing of bullshit excuses, maintain these structures?
- The fingerprints of established social and institutional groups are "all over" our projects:
    - What gets mentioned, what doesn't?
    - Whose authority is acknowledged, whose left implicit?
- How does the idea of "meritocracy" function in teaching and research?
    - How can we redefine merit?
    - Is merit a helpful rubric, and if so, for what?
- How do institutions/structures discourage intersectionality? What can we do to change this dynamic?
- What communities of study, such as queer culture or deaf culture, and their associated new knowledge structures, might support our research? Which, such as education privatization movements, might not? How do these relate to classroom cultures?
- How can we challenge STEM cultures but still give voice to marginalized communities?

Participants also wondered about the **field of engineering** itself; research questions centered on how engineering is currently defined by stakeholders and those without stakes, and the nature of interactions of one's identity with engineering education and culture:

- What is the socialization process (or processes) through which students learn to (re)interpret their identities within engineering?
- How do we help people understand engineering culture as a dynamic, not a monolithic, static, or rigid sector?
- How can we support the profession of engineering as a collective while valuing individuality?
    - What does professional identity provide to enhance just opportunities?
    - Is professionalization experienced differently by different participants?
- Why are engineers so "snooty," and does that perceived exclusivity have consequences?

Participants then focused on the nature of **institutions**, wondering how an individual's identities interact with the constructed identity of a larger institution. Who does an institution recognize and value, who is made invisible, what are institutional norms? How is disability perceived?

- What are the institutional contexts surrounding identities?
    - Do institutional discussions of diversity/inclusion focus on only one or two identities as "diverse"?
    - What happens when there's not a box to check? How does erasure impact the individual, the collective voice/visibility of the group, and research funding to broaden participation?
    - What and who is/are invisible?
- In what ways do/can we move discussion of disability in diversity beyond discussion of ally accessibility?
- How do/can funds of knowledge/community cultural wealth impact the institutional level?

Participants also questioned the role of institutional and educational **structures and policies** in supporting persons from marginalized populations to promote inclusion calling for "top-down" support and questioning of power structures:

- How do we "shine the light" on institutional reward structures and how they make and remake mind-sets?
- How do we work around the division of labor (research-teaching-student affairs) in higher education to broaden participation and enhance student success in engineering?
- How best to explore the system within which research happens?
    - Where do we delimit the system? Institution? Society? Nation or globe? Economic system?
- How can we explore and convey the need to add the LGBTQ+ category to university admission?
- How to address a hypocritical power structure? (Including administrative policy, government)
- In defining intersectionality, how much is it about the individual level versus the structures and social contexts that bring individuals together in shared environments?
- How do we "sneak" diverse identities into search committees?
- How can we do more to acknowledge "funds of knowledge" in maker spaces as a means to broaden participation?
- How do we help faculty, administrators, students, and others to understand the value of inclusion and put it into practice at the structural level?
- How are ruling relations (which function to gender/race/ability limit institutions) codified from norms?

Participants also identified questions related to **activism, allyship, and the role of change agents** within institutions, making calls for change, and questioning how to make policy change and who should lead these efforts:

- Faculty culture—starting revolutions.
- How to engage faculty to be updated and/or change their teaching style?
- To what extent are teacher prep programs preparing students to teach in diverse settings?
- Who do we leverage to bring policy change to institutions?
- What is the role of ALLYSHIP in promoting cultural change in engineering?
- How do we make a call for urgency to start institutional change?
- How do/can professional societies (SWE, NSBE, etc.) promote intersectional thinking?
- How to get funding for the LGBTQ+ community from federal agencies?

Participants identified some key research questions relating to **students.** They point to the influences different factors have on learning and identity development as well as on recruitment and retention, what students bring with them to their education, and how to motivate students to engage in thought and discussion about diversity and genuine inclusion:

- How do we investigate how the body matters to our students' experiences of engineering?
- What is the role of emotions in student learning?
- What is the role of community, possible selves, and self-efficacy for individual-level retention?
- What does it mean to feel like an "imposter" based on a particular part of our identity?
- How can we have students self-identify the identities that matter the most for them?
- Exploring nontraditional pathways to engineering, related to funds of knowledge; what do students bring with them to STEM?
- What intersections increase the successful participation of students with disabilities in engineering and STEM?
- What specific challenges do students with disabilities face with respect to the pursuit of STEM?
- I have read research on providing support groups for women in engineering: findings say that women find the support groups beneficial but do not like that they are singled out. What do we do with that?
- Does the focus on diversity and even intersectionalities gloss over that we are asking students to assimilate into an unjust/discriminatory system rather than trying to transform the system? How so we empower students by understanding this?
- How can we engage "majority"/privileged engineering students in these discussions in meaningful ways?
- How do students perceive diversity of thought?

Other questions related to **classroom spaces and practices** and how they can be made to reflect inclusive values on campuses:

- So-called inclusive maker spaces: are they and if not, how can they become inclusive?
- What spaces are made for disability on higher education campuses?
- How does the geography of a classroom produce barriers to inclusion?
- Classroom practices from Deaf classrooms that can be brought into Hearing cultures – what can we learn from what we generally treat as exceptional pedagogical practice?

- What can be learned and transferred from Hearing studies?
    - Deaf Gain: What can Hearing culture classes learn from tenets of Deaf Gain?? How are they beneficial even when a Deaf person is not present?
    - Deaf world, communication repair, and support is common—does hearing have a comparable praxis?
    - Is English really a language? Can it possibly handle spatial topics of such deep complexity as engineering? (Referencing deprived vocabulary.)
    - How might we deal with lip reading deficiency among entering 1st year Hearing students?
    - Most Hearing students are born to Hearing parents; how can we support low-gesture 1st generation signers?
- Are there other systematized or organized approaches to particular disabilities besides Deaf that may offer similar suggestions?

In thinking about who engineering education programs **partner with, advertise to, recruit from, and devote outreach effort to,** participants wondered what could be done to make these efforts more inclusive:

- Many of the concepts above were considered in the context of post-secondary education. But participants indicated that many may be pertinent to K-12.
    - How can stakeholders work with the idea of intersectional identity at the K-12 level more effectively?
    - What ideas of identity are currently being used uncritically in K-12 settings?
- Who do engineering programs advertise to? (e.g., traditional students, evidence: summer bridge programs living learning communities) What can be done for nontraditional students?
- Are all outreach initiatives crafted equal/properly targeted? Do top-down outreach events exclude and prescribe more than include?
- As we explore "who's not at the table," we should look at transition points along the engineering pathway, starting at K-12 through career. Transition points help us answer important questions about retention and persistence in the field.
- How do we create more intersection between community colleges and pre-college/4-year institution transitions for marginalized groups?

Thread 4: What Educational Practices or Experiences Inform Your Research?

Institutional structures and barriers: Navigating and connecting

Society, institutions of higher education, and funding agencies dictate what is considered research, the ways in which research is approached and conducted, and how findings are disseminated. Currently, institutions and funding agencies are creating barriers to scholars performing research that is inclusive and that creates inclusive change and practice. For example, the lack of recognition and reward structure for research that advances diversity and inclusivity limit the feasibility of developing such research and practice.

Changes to priorities and values that promote authentic and effective research must happen for transformative scholarship to occur that advances a welcoming and inclusive campus and societal environment. Institutions and departments of engineering education can make inclusion a priority through measures such as implementing student and faculty policies, faculty, and staff training programs, funding

and resources, campus and community space, and messaging. All university leadership, administration, faculty, and staff should be engaged with knowledge and training related to inclusionary practices to cultivate cultural shifts across and at all levels of a campus—not just in a select few departments or among a few faculty. There should also be emphasis placed on enhancing faculty search practices by explicitly requiring candidates to demonstrate their commitment to diversity and inclusion through their research and teaching. One way to achieve this could be to require that candidates submit a diversity statement along with their teaching and research statements, and that appropriate weight is given to the diversity statement as validation of its critical importance to achieving the academic mission.

The current landscape of higher education and engineering education makes it difficult for students from marginalized populations to succeed. In particular, the legal protections offered to persons from marginalized populations are limited and requirements making universities inclusive and equitable in access are lacking; this is particularly true for persons within the LGBTQ+ community. Universities must consider the needs of *all* their students, faculty, and staff beyond mere legal requirements in order to signal that the university values these persons. We do not want to send the message that students from marginalized communities need to be "fixed," but helping students address structural conditions by identifying ways engineering and higher education currently operate can make navigating these structures and dynamics easier. Connecting students from these populations with members within and beyond a particular discipline or campus community utilizing methods and technology/online platforms that aids their success is another navigational strategy.

Structuralized dualistic experience: Boxes, power, truth, identity, and fit

Societal and institutional structures create a normative set of values and beliefs that (re)create a normalized perception of expectations and reality. Thus, a dualistic conception of engineering and higher education is created, dividing anyone and anything that falls within "the normal" from everything else that falls outside of this box. Truth is seen as objective, representing experiences of individuals whose identities fall within the lines that construct "the box" of normalcy. Instead, truth should be recognized as a non-dialectic reality of infinite interactions and intersections of experience, truth, and reality. Awareness of this structured dualism is necessary to erase the privilege and oppression it creates. Engineering research should be informed and influenced by critical approaches that develop researcher and community awareness of the ways in which we are affected by systems of privilege, power, and oppression.

Engineering education customarily does not take into account the multiple backgrounds, life experiences, and circumstances of its participants. In fact, by privileging dominant and normalized experiences, identities, and knowledge, even well-intentioned programming assures the experiences of individuals from marginalized populations are largely ignored. Classrooms, pedagogies, and research are affected by this alignment. Research in engineering and engineering education should be conducted to deconstruct "the box" and the idea of the typical engineer. Inclusive practices and research build environments that meet each student, faculty, and staff's unique needs and abilities.

Authentic inclusion and partnership: Building culturally responsive campus and classroom learning environments

Inclusive research and practices should be co-constructed by educators and individuals from marginalized communities. This partnering helps to authentically drive and sustain efforts and environments that promote diversity and social justice. Currently, faculty and university administrators are

not supported in efforts to create inclusive campus environments and practices. Few persons associated with a university engage in this kind of work and thus transforming classrooms to become inclusive spaces may require significant mentoring and training of new and established faculty guided by experts in social justice research and instruction.

STEM classrooms and curricula are viewed by many within the educational and policy establishments as separate from dialogues and knowledge about power, privilege, and oppression. This dualistic philosophy structuralizes the classroom to normalize teaching methods and topics that reinforce and perpetuate oppression and privilege. Unfortunately, many engineering faculty members do not see the relevance of engaging in these topics, are uncertain of how to incorporate considerations of accessibility and inclusion into their disciplinary courses, or feel unprepared to lead discussions within their classrooms with students. They may also fear neglect of what they view as traditional engineering content, with attendant consequences for their status as instructors.

Mindful and reflexive thought should guide course and space development rather than discussions and actions that are in response to a misstep. Designing all spaces on campus to be accessible and inclusive will benefit all students from this intentional design, not just those with differing ability. Following universal design principles to proactively create inclusive spaces rather than reactively offer accommodations when barriers arise communicates to all students that they are valued and their presence does not represent an afterthought that needs to be accommodated. With this pivot towards proactivity, individuals may naturalize their attention to such design principles, and institutions may be more willing to support the labor and resources needed for the creation of accessible and inclusive settings.

Inclusivity, pedagogy, and training must be interwoven in ways that align with building critical awareness and are accessible to *all* individuals. These must foster practices and strategies that are culturally responsive, accessible, and inclusive, and build learning environments that value every student and advance their academic and personal success.

Accessible research to practice: Partnering to create change through implementable research outcomes

Research outcomes are often not translated into actionable models and ideas for practitioners that can be implemented in straightforward ways. Adoptable practices should help practitioners and educators feel comfortable and qualified to lead efforts to build a sustainable inclusive campus and learning environments. Researchers and practitioners should partner with individuals from marginalized communities to co-construct research studies in ways that are inclusive. Research outcomes must be disseminated in ways that are easy to find and easy to implement.

Thread 5: What Are the Things You Wish You Knew to Do Your Educational Practice Better?

Participants of the WNATT event represent many stakeholder positions around the table—faculty in a range of higher education institutions, practitioners, education researchers, administrators, staff, and program leaders. While the professional roles differ, many participants shared similar questions about how they could better understand, support, and educate engineers in their institution or organization. Questions centered around how they may bring people from marginalized communities to their research or practice tables in authentic ways, how to promote buy-in and sustained culture change within their

organization, how to incorporate students' evolving identities into engineering classrooms, and strengthening the research-practice connection.

"Nothing about us, without us"

Participants pondered the goals, outcomes, and ethical implications of work undertaken with these communities, emphasizing the need for true inclusion as the goal as opposed to simple compliance with policy or law. While recognizing that studying and objectifying the experiences and identities of persons from underrepresented communities may be necessary for visibility, participants, again, emphasized the importance of *working with* and *walking with* persons from underrepresented communities in research. Participants questioned how to conduct inclusive research and practice or take on advocacy roles:

- How to include persons from marginalized communities in research who may not wish to be studied, or who may be at risk of being ostracized for sharing their experience (i.e. veterans or service members)?
- How to find out about the identities of students at one's own institution when universities do not ask such questions about their students?
- How to engage students as community focus groups or committees to address specific issues at universities (e.g. in the design of spaces or services offered)?
- How to confront micro aggressions they observe or experience themselves. Marginalization and discrimination is not solely a student experience.
- How to break social stigmas associated with membership of a marginalized community?
- How to reframe work focused on these populations from a more asset-based perspective treating social identities (and associated experiences) not as a "problem" to "fix."
- How to reframe the experiences and skills of persons of marginalized identities as being valuable within engineering and as potentially increasing students' cognitive abilities and engineering competencies (i.e. multilingualism of first generation students).

Cultures of change within institutions and organizations—getting and sustaining buy-in

Participants pushed for a move away from short-term solutions in the form of programs and interventions in favor of more fundamental and sustained change. The wished to encourage a climate that promotes inclusion at all levels rather than imposing mandatory activities or training. To this end, participants wanted to better understand the potential change structures operating within institutions of higher education, professional organizations and societies, and within the larger culture of engineering. For example, many wondered:

- How to gain buy-in from stakeholders around the table (students, faculty, staff, leaders, administration, professional societies, etc.).
- How to bring all persons (not just those conducting inclusion work) into the "learning zone" of exploring and adapting practice to diverse populations and be willing to tolerate the discomfort that may accompany work and reflection around inclusion.
- How to start conversations about diversity and inclusion within all engineering spaces (K-12, community colleges, universities, and professional/technical societies) and with those who are most resistant.
- How professional societies for "invisible groups" (LGBTQ+, veterans, etc.) could be engaged to inform discussions and provide support in inclusion efforts.

Wishing to know what the "best practices" for initiating and sustaining change may be, some participants pointed to learning from and incorporating insights/ideas from other research communities and contexts outside of engineering to inform practices. Some wondered what may be learned from engineering sub-disciplines that appear to have greater success in diverse student enrollment (e.g. environmental or biomedical engineering as compared to aerospace engineering). Many wished to identify which programs or institutions are genuinely supportive and engaged in this work as opposed to simply marketing diversity efforts. One such program, the Making Academic Change Happen workshop developed at Rose-Hulman institute of technology, was identified as a model for implementing institutional change.

Policy and funding

Participants acknowledged the role of funding and policy in the promotion and sustainability of organization-wide cultural shifts towards inclusion. Participants pondered the role and vision of policy reform in this work, especially in light of the perception that many stakeholders view inclusion work as "irrelevant" to STEM education. Others wished to address the broader political landscape operating within and surrounding education wondering how to make diversity and inclusion work a priority in state legislatures. Participants asked questions like:

- How might policy re/inform practice?
- How might individuals and institutions be held accountable for promoting and sustaining inclusive practices?
- What implementation strategies may be engaged?
- What does buy-in look like?
- What different forms of writing may researchers, practitioners, and inclusion advocates adopt to more effectively influence policy and institutional change?

Desires to shift the culture within many institutions of higher education to stop "outsourcing" inclusion work and stop relying on external funding to address issues and challenges related diversity and inclusion were voiced. Many participants wondered:

- How to most effectively interact within administration.
- What are the most effective strategies for generating internal financial support for institutional change?
- How to expand support systems and programs for marginalized groups, especially when there is insufficient funding available from support services.

Faculty

Other buy-in considerations centered around faculty as players in leading and sustaining institutional change. Specifically, how faculty may support or hinder cultural change, and how to ensure that those *outside* of the underrepresented community participate and listen. Participants posed questions such as

- How can we get faculty to value diversity in engineering and gain buy-in for inclusion efforts?
- How can we encourage and support faculty (including in the K-12 levels) to effect institutional change when they are already so over-extended?

- How is “success” as a faculty member currently defined and how could the evaluation/promotional review process encourage inclusion efforts in the classroom as well as in research?
- How can we integrate training on inclusion, accessibility, and culturally responsive pedagogy into the education of all students—that is, to empower faculty to go beyond the technical subject matter?

Student identity

Participants also desired to know more about how institutions and engineering educators may learn about the diverse and evolving identities of engineering students—those in their classrooms and more broadly in engineering education programs. It was noted that students possess multiple developmental or transitionary identities as learners and budding engineering professionals in addition to their social identities and background experiences. Many wondered how to increase the visibility of diverse student backgrounds so that diverse identities and interests may be recognized in the classroom context. Participants also called for student identity knowledge to be explicitly incorporated into classroom practices and into engineering education innovation. Some wondered how engineering programs could build communities among students and create internship or co-op experiences that are accessible to all learners (focusing on low-income students and students with disabilities)?

Researcher-practitioner partnerships

Among participants, there exists a perception that research-based knowledge assumes a privileged position over the experiential knowledge of practitioners, and that theories and methods of traditional education research prevail. A challenge to research societies and conference organizers to co-construct theoretical knowledge with education practitioners (including community college and K-12 faculty) was issued. Discomfort with theory and research methodologies may be an additional disconnect between theory and practice, as some participants wondered how they might successfully adopt/adapt research knowledge and skills despite inexperience within the realm of education research. One participant offered the development of a dictionary of sorts in which educators and researchers may collectively compose descriptions of theories used in their work as a way to inform and implement theory. Others wished to build or find a community of engineering education researchers with whom they could conduct research, develop mindful and reflective practices, share advice for gaining support and demonstrating positive outcomes of inclusion efforts, and help further incorporate theories into their practice and use their practice to inform theory.

Next Steps

Building a New Research Agenda: What Will Success Look Like?

As planned, many of the exercises, reflections, and strategies articulated over the course of WNATT were directed at studying the experiences of LGBTQ+, veteran, LIFG, or disabled individuals, both in engineering schools and those who might someday seek entry into the discipline. The resulting research agenda will consider points raised in all of the threads that made up the meeting, and importantly, integrate our conversations with existing scholarship on race, gender, and ethnicity in BPE. The identities at the center of WNATT are themselves the result of cultural and institutional conditions and do not stand apart from others operating in our schools and workplaces; the networks generated by this workshop will extend to include scholars of all communities, it is hoped.

Despite the rich anecdotal content and analytical findings of WNATT, the fundamental question of "who" enters the engineering profession, the college classroom, or the spaces in which we study diversity remains unwieldy. If it were otherwise, simple conceptions of inclusion and welcome would have solved issues of U.S. STEM inequity long ago. Instead, we have raised complex issues regarding intersectional identities, context-dependent experiences of learning and work, and how inclusive engineering education research itself functions within those same conditions. But our work together at WNATT on the questions of how "who" happens did provide workable lessons. Crucially, it generated ideas for best practices on BPE research that we understand may be difficult to enact, confusing in some regards, and even incompatible with one another in some cases. It is this indeterminacy that we feel distinguishes WNATT from many other projects on engineering diversity, not simply its attention to understudied social groups. That openness to as yet unknown framings and questions will be the heart of the research agenda deriving from WNATT.

The next phase of this work will center on issuing an invitation to the wider body of researchers, practitioners, and policymakers—in addition to re-engaging WNATT participants—to contribute to crafting the research agenda. We are eager to incorporate these additional perspectives and seek input from individuals who were not part of the WNATT event as we shape and disseminate the research agenda. We invite readers to join us and our numerous partners in the work, explore this project, and learn about our other ongoing inclusion efforts by visiting **www.inclusiveengineering.org**.

Acknowledgments

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We also want to express our gratitude to those who attended the WNATT event itself. This gathering was far richer and more generative than we could have envisioned, and the vital role played by our participants in its success—both through their contributions and their profound challenges to our thinking—cannot be overstated. Our time together exceeded our greatest hopes for this project and we look forward to more opportunities to work with these extraordinary colleagues.

Finally, we offer our thanks, and awe, to *all* the scholars, educators, employers and students who have pushed, often in the face of deeply discriminatory conditions, for greater equity in American engineering. We see WNATT as just one effort in a broad landscape of such interventions and want to recognize the inspiring creativity and patience of all those involved in the everyday work of inclusive teaching and learning.

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