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Moments that Matter: Early-Career Experiences of Diverse Engineers on Different Career Pathways

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\begin{abstract}
While many early-career engineers in the United States leave the field of engineering in the first few years of their careers, we know little of their early professional experiences and reasoning for career plans. We conducted 33 semi-structured interviews with early-career engineers, comparing the experiences of engineers across intersections of gender and race. In particular, we examine meaningful early-career experiences and how these connect to the innate needs of autonomy, competence, and relatedness, as well as career intentions. Top moments on the job were often first-time experiences and milestones that enhanced the engineers’ sense of competence. Meaningful moments connected to relatedness were more often positive than negative experiences for White men, whereas experiences undermining relatedness were more common for people of color and/or women. Connections to autonomy emerged more in bottom moments, especially for White engineers. Across different intended career pathways, early-career engineers often evaluated their experiences regarding their ability to work effectively and through social validation from peers and managers (or undermined by a lack thereof). The results indicate the need for a greater understanding of early-career affordances in supporting entry and retention in the engineering workforce by promoting individual effectiveness and social validation.
\end{abstract}

\section*{Background}

Although many engineering graduates start their careers in engineering fields, they tend to pursue a larger variety of jobs during the first few years of their career.\textsuperscript{1} Disconcertingly, graduates who performed better in school leave more often during the initial years, implying that educational success is not indicative of one’s willingness or opportunities to stay in engineering.\textsuperscript{2} Rather, the work experience of an engineer is subjective and personal, situated in specific contexts associated with distinct social and infrastructural barriers.\textsuperscript{3} However, studies on the socially situated nature of engineering have primarily focused on experienced or expert engineers,\textsuperscript{4} reflecting the experiences of those opting to stay in engineering. Complementing these insights with a more nuanced understanding of early-career...
experiences can inform the immediate realities of entering the workforce. Early socialization experiences influence either staying in the field to rise to experienced and expert levels in engineering or opting for alternative career pathways, acting as turning points, encouraging integration or distancing from organizations. As such, a deeper understanding of these experiences can lend itself to providing more supportive entry positions for engineering graduates and retaining a diverse workforce.

Emerging studies (e.g., in Engineering Studies’ 2021 Special Issue and European Journal of Engineering Education’s 2022 Special Issue) that do examine early-career socialization experiences at engineering workplaces suggest that these experiences are gendered and racialized. Indeed, White men continue to represent the largest demographic group across the U.S. engineering workforce. Therefore, ‘White’ and ‘man’ privileges exist simultaneously in this context, causing socialization processes, barriers, and challenges to differ across intersections of gender and race, i.e., between White men, White women, men of color, and women of color. Engineers with certain combinations of underrepresented identities might be perceived as less competent, feel less welcome, and face more harassment, leading to differences in early socialization experiences at the workplace, which, in turn, may translate to different career outcomes. Additionally, underrepresented groups, such as women and people of color, must maneuver developing an identity that matches both ‘engineer’ and their gender and race. This tension is described in self-determination theory as being between the constructed ‘identity’ and the innate ‘self’, where the ‘self’ contributes to growing and developing the identity ‘in a continuous interaction with the social environment’.

Self-determination theory offers one lens to examine experiences to better understand the social environment’s influences. It focuses on the social and contextual conditions that enhance three innate, foundational needs that support intrinsic motivation when met:

1. **Autonomy**: having volition, agency, and a sense of choice, being able to make decisions regarding one’s actions and circumstances;
2. **Competence**: mastering skills, overcoming optimal challenges, and having an impact on one’s environment;
3. **Relatedness**: interacting with and connecting to others in a meaningful way.

All three innate needs have been found to apply in cultures worldwide, connecting to identity development or diffusion, as well as well-being, job satisfaction, and profitability. As such, innate needs are meaningful for examining work experiences and their consequences to individuals and organizations.

Beddoes studied the early-career experiences of eighteen engineers of diverse backgrounds to reveal the power and privilege newcomers face. We follow this line of work and complement it with our dataset, zooming in on the first two years on the job of engineering graduates. In line with examining the personal experiences of early-career engineers, we adopt self-determination theory as a framework to understand underlying meanings in experiences related to self and identity development. Based on 33 interviews of early-career engineers employed in different organizations in the United States, we ask, ‘What type of moments on the job do early-career engineers of diverse race and gender construe as meaningful, and how do these connect to further career intentions in the field?’.
Method

Aiming to investigate what diverse early-career engineers experience as meaningful moments in their profession and how these connect to their career intentions, semi-structured interviews were conducted with 33 engineers working across the United States. The engineers’ descriptions of their ‘top’ and ‘bottom’ moments on the job were analyzed using Ryan and Deci’s^20 self-determination theory, comparing the content and distribution across different needs, then connecting this to career intentions (Figure 1).

Research setting and participants

Interview invitation emails were sent to a subset of participants from four universities in the United States in a longitudinal research study^21 who were recent bachelor’s degree graduates in engineering, employed full-time, and had reported being willing to consider interview requests. Limiting the study to bachelor’s degree graduates and full-time employees allows us to enhance our understanding of the influence of gender and race specifically, without the interference of academic experience and part-time versus full-time status. Thirty-five out of 67 invited respondents agreed to an interview. Each participant received a $20 gift certificate for Amazon.com.

All participants had graduated more than one but less than two years before the interview and held engineering positions at consultancies, private companies, or public organizations in various sectors. Two participants were removed from the data set, one as he had not been asked to share his career intentions and one as he preferred not to report his race, both critical variables in the current study. Table 1 details the remaining 33 participants’ gender, race, and age at the time of the interview, obtained from previous survey responses. Gender is based on the participants’ self-reports in the Engineering Majors Survey^22 instrument for ‘sex’, but we interpret patterns in this response category as gendered (see Magliozzi, Saperstein, and Westbrook^23 on how to measure gender on surveys better). The survey included options of ‘other’ and ‘prefer not to answer’ for sex, but none of the participants selected those options. Race is based on the participants’ self-reports in the Engineering Majors Survey^24 instrument for ‘ethnicity’, but we interpret patterns in this response category as patterns based on observed race (see Roth^25 on how to measure race better).

We divided the participants into four groups: (1) engineers who self-identified as White and man ($n = 14$), representing the majority of U.S. engineers,^26 (2) engineers who identified as White and woman ($n = 11$), (3) engineers who identified as Asian or Asian American,
Table 1. Participant demographics, pseudonyms followed by age and discipline.

<table>
<thead>
<tr>
<th>Men (n = 18)</th>
<th>Women (n = 15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White (n = 25)</td>
<td></td>
</tr>
<tr>
<td>Elijah (23), Electrical eng.</td>
<td>Ava (23), Civil eng.</td>
</tr>
<tr>
<td>Finn (23), Computer sc.</td>
<td>Charlotte (23), Civil eng.</td>
</tr>
<tr>
<td>Benjamin (24), Computer sc.</td>
<td>Faith (23), Civil eng.</td>
</tr>
<tr>
<td>Daniel (24), Computer eng.</td>
<td>Grace (23), Mechanical eng.</td>
</tr>
<tr>
<td>Gabriel (24), Chemical eng.</td>
<td>Emma (24), Mechanical eng.</td>
</tr>
<tr>
<td>Isaac (24), Industrial eng.</td>
<td>Harper (24), Mechanical eng.</td>
</tr>
<tr>
<td>James (24), Electrical eng.</td>
<td>Nora (24), Civil eng.</td>
</tr>
<tr>
<td>Parker (24), Bio(medical) eng.</td>
<td>Kaitlyn (25), Industrial eng.</td>
</tr>
<tr>
<td>Quinn (24), Computer sc.</td>
<td>Layla (25), Mechanical eng.</td>
</tr>
<tr>
<td>Ryan (24), Computer eng.</td>
<td>Mia (25), Civil eng.</td>
</tr>
<tr>
<td>Oliver (25), Mechanical eng.</td>
<td>Delilah (27), Computer sc.</td>
</tr>
<tr>
<td>Noah (26), Bio(medical) eng.</td>
<td></td>
</tr>
<tr>
<td>Kayden (29), Civil eng.</td>
<td></td>
</tr>
<tr>
<td>Henry (43), Computer eng.</td>
<td></td>
</tr>
<tr>
<td>Hispanic or Latinx (n = 2)</td>
<td></td>
</tr>
<tr>
<td>Alexander (23), Mechanical eng.</td>
<td>Julia (24), Bio(medical) eng.</td>
</tr>
<tr>
<td>Asian or Asian American (n = 1)</td>
<td></td>
</tr>
<tr>
<td>Carter (24), Computer sc.</td>
<td>Isabella (25), Bio(medical) eng.</td>
</tr>
<tr>
<td>Multi-racial (n = 5)</td>
<td></td>
</tr>
<tr>
<td>Liam (24), Aerospace eng.</td>
<td>Brooklyn (23), Computer sc.</td>
</tr>
<tr>
<td>Mason (25), Nuclear eng.</td>
<td>Olivia (24), Electrical eng.</td>
</tr>
</tbody>
</table>

Hispanic or Latino or multi-racial and man (n = 4), and (4) engineers who identified as Asian or Asian American, Hispanic or Latina or multi-racial and women (n = 4). While the proportion of interviewees of color is smaller than that of White interviewees, this approach supports understanding some intersectional experiences, focusing on the various potential effects of White and man privilege.

Data collection

The semi-structured interviews conducted as a part of the Engineering Majors Survey were built around open-ended questions on how the participants ended up in their current jobs, their experiences at the job, their career plans, and reflections on their education. The interviewers and two primary data analyzers were White Millennials (the same generation as most participants), non-native to the United States, and working at research groups in engineering departments of universities in the United States or Northern or Western Europe. Excluding set up, practicalities, and closing, interviews lasted an average of 40 min and were audio-recorded and transcribed verbatim for analysis.

The present study focuses on responses to three of the themes of the interviews: their intentions going forward (whether staying in their current role or not), their three top moments so far in their jobs (representing experiences supporting innate needs), and their three bottom moments (representing hindering experiences). The reflections on top and bottom moments represent participant-selected critical incidents, which are more likely recalled in detail and accurately even in retrospective interviews. In this study, the reported moments are not taken to reflect the best and worst moments. Instead, the purpose is to examine memorable events that provide ‘first hand evidence of the relationship between context and outcome’ – the outcome being meaningful professional experiences and how they are made sense of. No definitions were offered for ‘top’ or ‘bottom moments’ as we did not want to impose any considerations on what the participants found meaningful. Instead, the aim was to provide a thematically uniform prompt for their
reflections. As the primary purpose of the prompt was to initiate a reflection on meaningful experiences, we did not enforce selecting three moments. Instead, we allowed the participants to discuss freely following the prompt.

Due to the flow of conversation and time constraints, only top moments were elicited in four of the 33 interviewees, all wanting to leave for a different position (Alexander and Carter, Hispanic or Latino men, Benjamin, a White man, and Brooklyn, a Black or African American & Hispanic or Latina woman). Across all 33 interviewees, each interviewee shared between 1 and 4 top moments, with an average of 2.8 per person. From the 29 interviewees that received both prompts, an average of 2.0 bottom moments was shared, ranging from 0 to 4 moments per person. While the flow of conversations resulted in different numbers of responses skewing the numbers, all interviews in the data set offer insights into the thematic content of the meaningful moments and are therefore included.

Data analysis

First, two of the authors went through the interview transcripts to identify responses to the top and bottom moments and code them as separate instances, resulting in 94 coded top moments and 58 bottom moments. To analyze what early-career engineers consider meaningful professional experiences and how they make sense of these, the thematic content of these moments, as the interviewees described them, was mapped on a semantic level\(^{31}\) to how they impact the three innate needs and their four intersections (as some experiences fundamentally connect to several needs\(^{32}\)), supporting for top moments, or hindering for bottom moments. This is by no means the only possible framework for these experiences, nor do we claim the engineers are necessarily cognizant of the frames they invoke for their experiences. Rather, the framework offers one way of making sense of the engineers’ experiences. Similar events, such as lack of work or praise from a colleague, could be connected to different sets of needs, depending on how the interviewee framed the experience. Two authors went through all the moments, discussing any differences in coding until an agreement was reached on which need(s) the moment was connected to. Table 2 (below) provides examples of coded quotations.

Second, the same two authors went through all interview transcripts again, this time to identify responses to the career plans prompt, then coded whether the response reflected an intention to stay at the organization or leave (or unsure) and whether the engineer expressed aiming for a different position or the same. The same authors again discussed any differences in coding until agreement was reached. We then compared the distribution and content of moments across future intentions and intersections of gender and race to examine whether there were differences in the types of moments or reasoning across the groups.

Results

Meaningful moments of all engineers

Of the 152 moments reported by all 33 engineers, competence was most often affected, either solely or combined with other innate needs (Figure 2). These moments were predominantly positive. Moments tied to autonomy, in contrast, were least frequent and largely negative (Table 3).
Table 2. Example coding to innate needs, including reasoning.

<table>
<thead>
<tr>
<th>Quotation</th>
<th>Code</th>
<th>Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘It’s always frustrating when a test doesn’t work out the way it should have, or the data doesn’t end up being useful at all [...]. Just the delays on the project I’m working on.’ (Quinn, White man)</td>
<td>Bottom moment coded into competence</td>
<td>The coding reflects the expressed frustration for generating useless work outcomes and delays.</td>
</tr>
<tr>
<td>‘We did night shifts for like five days [...] and it was like 8:00 at night, we hadn’t had dinner yet, so I was tired, I was hungry, and [...] the CEO, [...] he was getting very, very frustrated because things weren’t working very well [...] and so he kind of took it out on us.’ (Gabriel, White man)</td>
<td>Bottom moment coded into competence, relatedness, and autonomy</td>
<td>The coding reflects the expressed inability of the engineer to do the work, feeling treated unfairly, and not being able to make their own decision.</td>
</tr>
<tr>
<td>‘I was working like seven [...] in the morning until eleven at night every day, and then on the weekends [...]. It was like you would get up and go to the office, like fully knowing that you were not going to be able to leave until so late at night.’ (Kaitlyn, White woman)</td>
<td>Bottom moment coded into autonomy</td>
<td>The coding reflects the expressed inability of the engineer to make their own decisions of when to start or stop working.</td>
</tr>
</tbody>
</table>

Figure 2. Distribution of top and bottom moments into the innate needs with examples of moment content (e.g. 31% of all top moments connected to solely competence). Due to rounding, the top moment percentages add up to 101% instead of 100%.

Experiences connected to competence (or lack thereof) tended to be positive, connecting to most of the engineers’ top moments. Typically, these reflected big and small successes in one’s work and learning new things:

I happened to remember a specific slide from a previous case, and I didn’t think it was that big of a deal, but my manager’s reaction to that was like, ‘Whoa! How did you remember that?’ [...] It’s an easy job to feel like, day-to-day, you don’t know what you’re doing, even if you’re on the
Table 3. Distribution of top and bottom moments across study participants into the innate needs (e.g. 83% of White men’s top moments was connected to competence). Since moments could connect to multiple needs, the numbers add up to more than 100%.

<table>
<thead>
<tr>
<th></th>
<th>White men</th>
<th>White women</th>
<th>Men of color</th>
<th>Women of color</th>
<th>All engineers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supporting</td>
<td>Competence</td>
<td>83%</td>
<td>66%</td>
<td>56%</td>
<td>73%</td>
</tr>
<tr>
<td></td>
<td>Relatedness</td>
<td>67%</td>
<td>50%</td>
<td>78%</td>
<td>54%</td>
</tr>
<tr>
<td></td>
<td>Autonomy</td>
<td>22%</td>
<td>66%</td>
<td>33%</td>
<td>33%</td>
</tr>
<tr>
<td>Hindering</td>
<td>Competence</td>
<td>56%</td>
<td>59%</td>
<td>33%</td>
<td>48%</td>
</tr>
<tr>
<td></td>
<td>Relatedness</td>
<td>39%</td>
<td>20%</td>
<td>67%</td>
<td>52%</td>
</tr>
<tr>
<td></td>
<td>Autonomy</td>
<td>48%</td>
<td>39%</td>
<td>33%</td>
<td>48%</td>
</tr>
</tbody>
</table>

right track. So, I guess just those little moments of validation periodically are helpful to feel like I’m still on the rails. (Isabella, Asian or Asian American woman)

Experiencing a lack of competence was the least frequent connection to bottom experiences reported by women, both White (41%) and of color (33%) engineers. These often related to fearing developing a negative reputation. In contrast, competence was the most commonly unmet innate need in the bottom moments of the White men (56%) and men of color (59%), many of which centered around work not going according to plan.

Most of the time, I’m just sitting there at a computer, coding, which is pretty boring. And especially when [...] trying to step through and see when it was messing up and searching for that one thing. [...] There was like five weeks where I just didn’t accomplish anything. [...] Every day kind of being like, ‘Okay, I didn’t do anything again today.’ (Daniel, White man)

Bottom moments for women were most frequently connected to lack of relatedness (63% for White women and 67% for women of color), describing struggles with creating a sense of belonging.

In the beginning, it took them a long time to kind of get, I guess, on a roll with integrating me into the group, or a fair amount. (Mia, White woman)

For White women engineers, relatedness was more often connected to negative than positive experiences (63% bottom and 35% top moments), reporting inappropriate behavior from colleagues. For women of color, both top and bottom moments connected most frequently to relatedness (78% top and 67% bottom). For White men and men of color, bottom moments were seldom connected to relatedness (41% and 20%, respectively).

Positive relatedness experiences were connected to receiving recognition and experiencing camaraderie at the workplace. However, for White women and people of color engineers, these positive experiences were mainly linked to colleagues. In contrast, White men also shared many joyous moments of relatedness related to their supervisors and leadership, for Gabriel enhancing autonomy, competence, and relatedness:

The CFO, he asked me a question and said, ‘I have [...] a particular liquid, [...] what combination gets me this specific gravity?’ So, [...] I generated this chart that had ... you could see the different combinations that would get you this particular specific gravity. And it was a little bit more than what he had asked for, but I thought it was clearer. [...] And when I brought it to him in his office, he was like, ‘This is fantastic! This is great! Thank you!’ And that’s another example, where he was [...] really, really happy [...], and I was really satisfied to have done that for him. (Gabriel, White man)
Finally, all engineers reported more negative than positive moments connected to autonomy. Positive moments enhancing a sense of autonomy were typically related to having work variety or being involved in choosing what kind of work to do. Negative moments undermining autonomy revolved around not being allowed to do the work or being required to work overtime, sometimes hindering all three innate needs:

Initially, I was given two weeks to do the project. […] There were some issues trying to get the software loaded, […] so, by the end of the week, the first week, I only had two days to work on it. So, because I wasn’t making as much progress as they liked, they pulled me off it and put somebody else on it. […] So, that was frustrating, and my manager and I had a discussion about it. (Henry, White man)

Career pathways per group

Most participants had clear career intentions in the short term, and two engineers expressed considering a wide variety of potential future directions, ranging from staying to leaving engineering altogether.

Similar distributions were noted across White men and women, yet different for men and women of color. Relatively more engineers of color intended to switch organizations or leave engineering, whereas a larger proportion of White engineers planned to stay in the same organization. Table 4 summarizes the meaningful moments reported by the early-career engineers across gender, race, and career intentions, as described below.

White men in early-career engineering

Gabriel, Henry, Quinn, and Ryan indicated intending to stay at their organization in the same position (Table 5). Typically, they focused on building expertise, getting more responsibilities, and developing a reputation as a point of contact for an area of expertise.

I would like to be knowledgeable in one or two specific areas, that if somebody says, ‘Hey, we’ve got this issue; what do you suggest we do about it,’ and I would like to be that guy. (Henry)

These White men’s top moments were all connected to competence, typically involving acquiring skills or doing good work and superiors praising them, supporting all innate needs. Bottom moments described suboptimal team dynamics resulting in time-related issues – Gabriel reported having to work overtime and Quinn having insufficient time to carry out tasks, hindering all needs. Not being able to do his absolute best due to colleagues caring less hindered Ryan’s autonomy and relatedness, and passing code to a colleague who could not get it to work undermined his competence.

Beating my head on my desk for just days, more than a week, after I had finished something, and I was like, ‘All right, this is perfect! It works; it’s great.’ And I give it to somebody else, and they call me and say, ‘It doesn’t work, even a little bit.’ That was a pretty, pretty humbling moment. Pretty poor. (Ryan)

The intention to stay in their current organization but actively pursue a different position (voiced by Isaac, James, Kayden, Liam, and Oliver) was most common for White men. As reasons, they typically cited internal growth opportunities due to managers being supportive of learning or being offered to try a management role.

I’m going to finish this […] three-year program with an optional fourth year, where you’re given basically four technicians, and you’re their manager. So, at first, [it] is like: Do you want to go
<table>
<thead>
<tr>
<th>Stay (n = 8)</th>
<th>Intend to build expertise and become a point of contact for an expertise (n = 4)</th>
<th>Intend to add variety to their work (n = 3)</th>
<th>(n = 0)</th>
<th>Intends to continue the work she does (n = 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Doing good work and receiving praise (supporting competence); time-related issues or being unsuccessful (undermining competence).</td>
<td>New creations and praise (supporting competence); struggling with connecting, confidence being shaken (undermining autonomy, relatedness).</td>
<td></td>
<td>Making connections at a conference (supporting relatedness)</td>
</tr>
<tr>
<td>Advance (n = 12)</td>
<td>Intend to advance through internal growth opportunities (n = 5)</td>
<td>Intend to pursue additional schooling to get promoted (n = 5)</td>
<td>Intends to pursue additional schooling to get a more technical role (n = 1)</td>
<td>Intends to pursue additional schooling to get promoted (n = 1)</td>
</tr>
<tr>
<td></td>
<td>Good connections with colleagues and receiving praise (supporting relatedness); communication issues or feeling irrelevant (undermining autonomy).</td>
<td>Achieving goals, novel experiences (supporting competence); being disrespected (undermining relatedness)</td>
<td>Connecting, being appreciated (supporting all needs); getting a low test score (undermining competence)</td>
<td>Appreciation (supporting competence); making a public error (undermining competence, relatedness)</td>
</tr>
<tr>
<td>Switch (n = 3)</td>
<td>Intends to move to an in-house position from a consultancy to gain deeper access in development projects (n = 1)</td>
<td>Intends to aspire for more impact in the private sector (n = 1)</td>
<td>(n = 0)</td>
<td>Intends to get more ownership in a smaller organization (n = 1)</td>
</tr>
<tr>
<td></td>
<td>Being a valued resource (supporting autonomy and competence); wasting time (undermining autonomy, relatedness).</td>
<td>Being a valued resource (supporting autonomy and competence); wasting time (undermining autonomy, relatedness).</td>
<td>First-time achievements and appreciation (supporting competence); having no work to do (undermining all needs)</td>
<td>First-time achievements and appreciation (supporting competence, relatedness); lack of transparency (undermining relatedness, autonomy)</td>
</tr>
<tr>
<td>Leave (n = 8)</td>
<td>Intend to join or initiate a startup (n = 3)</td>
<td>Intends to work closer to friends and family (n = 1)</td>
<td>Intend to have more impact or explore options (n = 3)</td>
<td>Intends to get more challenge (n = 1)</td>
</tr>
<tr>
<td></td>
<td>Being the go-to guy, doing a good job, and getting people excited (supporting competence, relatedness); contributions being rejected (undermining competence).</td>
<td>Achievements (supporting competence); accidentally offending (undermining competence, relatedness)</td>
<td>Feeling successful, like they belong (supporting autonomy, competence); working overtime (undermining competence)</td>
<td>Learning opportunities (supporting relatedness)</td>
</tr>
<tr>
<td>Unsure (n = 2)</td>
<td>Intends to do something practical (n = 1)</td>
<td>Intends to find more balance (n = 1)</td>
<td>(n = 0)</td>
<td>(n = 0)</td>
</tr>
<tr>
<td></td>
<td>Bonding with colleagues (supporting relatedness); everything going wrong (undermining competence)</td>
<td>Learning and sharing (supporting competence); not being allowed to stop working (undermining autonomy)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 5. Distribution of meaningful moments across innate needs for White men per career pathway.

<table>
<thead>
<tr>
<th></th>
<th>Support (4)</th>
<th>Advance (5)</th>
<th>Switch (1)</th>
<th>Leave (3)</th>
<th>Unsure (1)</th>
<th>All (13)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supporting</td>
<td>Competence</td>
<td>100%</td>
<td>33%</td>
<td>50%</td>
<td>100%</td>
<td>50%</td>
</tr>
<tr>
<td></td>
<td>Relatedness</td>
<td>55%</td>
<td>80%</td>
<td>0%</td>
<td>75%</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Autonomy</td>
<td>55%</td>
<td>33%</td>
<td>50%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Hindering</td>
<td>Competence</td>
<td>78%</td>
<td>25%</td>
<td>0%</td>
<td>75%*</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td>Relatedness</td>
<td>44%</td>
<td>38%</td>
<td>100%</td>
<td>25%*</td>
<td>0%</td>
</tr>
<tr>
<td></td>
<td>Autonomy</td>
<td>44%</td>
<td>50%</td>
<td>100%</td>
<td>50%*</td>
<td>0%</td>
</tr>
</tbody>
</table>

*Benjamin not prompted for bottom moments.

into management or not? I decided, ‘I am going to try to do it,’ just because I was told that it would be kind of dumb just to turn down a really good opportunity. (James)

Their top moments reflected mostly relatedness, such as having good connections and feeling close to colleagues.

I work here for a year, and you feel like, well, I’ll know you, but you probably won’t be like a good friend of mine, or whatever. But just like work … working day-in, day-out with people and really getting to know your other coworkers. (James)

Additionally, they reflected positively on receiving a bonus, a special position, or praise from their superiors, adding to competence and relatedness.

From their bottom moments, autonomy or competence was limited when work did not go according to plan, resulting in delays or late nights.

There have been a lot of delays due to different manufacturing issues and some communication issues. So, some of it, maybe I’m not necessarily in control of, but definitely, I could have been more on top of things to prevent some of those delays. (Oliver)

Additionally, White men interested in growing in the organization described bottom moments of tedious work and feeling irrelevant, hindering autonomy.

Only one White man, Noah, intended to look for a similar position in another organization, hoping to move from a consulting company to an in-house engineer to gain deeper access to development engineering projects. Noah enjoyed speeding up the process when standing in for the boss, enhancing autonomy, and feeling like a valuable resource, enhancing competence. On the other hand, having nothing to do was a bottom moment, framed as hindering both autonomy and relatedness.

Benjamin, Daniel, and Finn expressed planning to leave engineering to do something different, driven by ambition and sharing options to join or create a startup.

I’ve kind of got a new passion for just making applications that people can use for data, and I’ve been kind of latching onto data science in my courses that I’ve been playing around with. So, I’ve actually been looking at going back and doing like a data science master’s, and possibly an MBA, possibly starting my own company. (Finn)

Despite their desire to leave, top moments were predominantly connected to competence and relatedness, referencing the joys of being the go-to guy and showcasing work successfully, enhancing both competence and relatedness.

I got to demonstrate [this thing] to a bunch of other people within the company who were also in the AI space, and they were all very impressed. It felt great to have validation for my work like that and sort of like that elevated me to ‘the guy to talk to’ about this type of thing, which […] feels great. (Benjamin)
Table 6. Distribution of meaningful moments across innate needs for White women per career pathway.

<table>
<thead>
<tr>
<th>Supporting</th>
<th>Competence</th>
<th>Advance (5)</th>
<th>Switch (1)</th>
<th>Leave (1)</th>
<th>Unsure (1)</th>
<th>All (10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competence</td>
<td>89%</td>
<td>74%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>84%</td>
</tr>
<tr>
<td>Relatedness</td>
<td>44%</td>
<td>32%</td>
<td>67%</td>
<td>0%</td>
<td>33%</td>
<td>35%</td>
</tr>
<tr>
<td>Autonomy</td>
<td>22%</td>
<td>21%</td>
<td>33%</td>
<td>0%</td>
<td>33%</td>
<td>22%</td>
</tr>
<tr>
<td>Hindering</td>
<td>Competence</td>
<td>33%</td>
<td>38%</td>
<td>100%</td>
<td>100%</td>
<td>33%</td>
</tr>
<tr>
<td>Relatedness</td>
<td>44%</td>
<td>77%</td>
<td>100%</td>
<td>100%</td>
<td>67%</td>
<td>63%</td>
</tr>
<tr>
<td>Autonomy</td>
<td>44%</td>
<td>54%</td>
<td>100%</td>
<td>0%</td>
<td>67%</td>
<td>52%</td>
</tr>
</tbody>
</table>

Moments of success were often shared as top moments, enhancing competence and sometimes relatedness, e.g. when the team got excited after fixing a long-term bug. Benjamin wasn’t prompted for negative experiences, but Finn and Daniel recalled hindering competence moments of contributions being rejected, such as their code being rewritten or their idea of hiring a designer being resisted.

Elijah was unsure about his next steps, enjoying bonding face-to-face with remote colleagues (enhancing relatedness) and feeling supported when a project was not going according to plan (simultaneously hindering competence and supporting relatedness).

**White women in early-career engineering**

Delilah, Emma, and Mia intended to stay in the same position (Table 6), emphasizing that staying would enable them to add more variety to their work and help the company succeed.

I’d like to stay in the 3D division, but I’d really like to […] be more involved in early prototypes and a little bit of programming or something, […] there would be a little more variety to it. (Emma)

They expressed top moments mostly connected to competence, enjoying creating new products or methods, especially when having these praised or adopted by others.

I had designed all these welding features and different things to make it kind of like […] a weld-by-number sort of thing. And it was just very satisfying to […] have the welder look at you and say, ‘This is like the easiest thing I’ve welded.’ (Emma)

Like the White men engineers with this same career plan, many bottom moments targeted team dynamics. However, where men lamented these dynamics influencing efficiency, for women, social impact was more prominent – their bottom moments described struggling with connecting to colleagues or having a team disbanded. Other bottom moments described making an ill-received suggestion in a meeting, receiving a product part all mangled after shipping, and needing to accept that not everything can be perfect.

The five White women intending to advance in the organization (Ava, Faith, Grace, Harper, and Nora) looked for external growth opportunities, such as pursuing additional schooling to increase the likelihood of being promoted or adding value to the organization.

Their top moments revolved around achieving career landmarks, predominantly enhancing competence, such as picking up work quickly, seeing their projects being put to use, or negotiating their career path in the organization. These experiences affirmed the engineers of their value in the organization. Other positive experiences were also mostly connected to competence: when traveling to sites, seeing their project implemented, providing design input that others agreed with, and having varied work.
It’s all about just traveling, which is really fun. Another one, we went up to Newport, Rhode Island, and we were assessing an existing wall there to see if they could punch a hole through the wall and see if a window could fit. (Faith)

Relatedness-enhancing experiences described receiving acknowledgment from supervisors and colleagues.

Compared to White men with the same career plan, White women engineers aiming to advance in their current organization reported a relatively high portion of negative moments connecting to relatedness, at 77 percent. They mentioned being bullied or disrespected or an instance of a work friend being fired. This was similar to White women intending to continue in their current position in the organization. Additionally, these engineers reported colleagues not taking their share of responsibility, and Faith and Nora lamented budget and time constraints and working overtime, hindering both relatedness and autonomy.

In the office still at 7:00 or 8:00 p.m., working on our [...] project. [...] They were like, ‘We’re going to have to stay extra hours and do really hard on this,’ and I felt like we did, and just their timeline was unrealistic. I was like, ‘Okay, like, I want to work hard for you, and I care about this.’ But at the same time, ‘I can only care so much, and I want to go home now!’ (Nora)

Only one of the ten White women, Charlotte, aspired to a similar position in another organization. She reasoned that moving to the private sector could afford her to see more impact than her current public organization offered.

Her top moments were first-time achievements and being appreciated, all supporting competence. Charlotte shared only one bottom moment describing working temporarily in a unit where everybody is just sitting all day, not teaching her, not working, not talking – hindering all three innate needs.

One White woman, Layla, had already left engineering for a new job closer to friends and family. Her three top moments connected to competence are meeting a deadline, receiving applause for an idea, and successfully releasing a test. Layla described a negative experience of being ‘given the wrong list of people to invite and missed a crucial person, and they were very offended’, hindering both competence and relatedness.

Kaitlyn expressed a desire for more balance in life but felt unsure about which career move would support that. Her top moments supported competence, describing realizing she learned a lot, getting positive feedback when presenting work, and seeing a year’s worth of work come together. Bottom moments, in turn, described having to work overtime or being scolded by a manager for taking a coffee break, both hindering autonomy and the latter also relatedness. A moment of messing up a test resulted in a reduced sense of competence.

Men of color in early-career engineering

None of the interviewed men of color wanted to stay in the same position (Table 7). Out of the four interviewed men of color, only Liam, an Asian American man, intended to pursue a different position in the same organization, a more technical role, by returning to school and getting a graduate degree.

Liam’s top moments supported all three innate needs, describing making friends, getting certified, and receiving a reward for good work. On the other hand, both his bottom
Table 7. Distribution of meaningful moments across innate needs for men of color per career pathway.

<table>
<thead>
<tr>
<th></th>
<th>Stay (0)</th>
<th>Advance (1)</th>
<th>Switch (0)</th>
<th>Leave (3)</th>
<th>Unsure (0)</th>
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</tr>
</thead>
<tbody>
<tr>
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<td>–</td>
<td>67%</td>
<td>–</td>
<td>66%</td>
</tr>
<tr>
<td>Competence</td>
<td></td>
<td>67%</td>
<td>–</td>
<td>44%</td>
<td>–</td>
<td>50%</td>
</tr>
<tr>
<td>Relatedness</td>
<td></td>
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<td>–</td>
<td>67%</td>
<td>–</td>
<td>66%</td>
</tr>
<tr>
<td>Autonomy</td>
<td></td>
<td>67%</td>
<td>–</td>
<td>67%</td>
<td>–</td>
<td>66%</td>
</tr>
<tr>
<td>Hindering</td>
<td></td>
<td>100%</td>
<td>–</td>
<td>33%*</td>
<td>–</td>
<td>59%</td>
</tr>
<tr>
<td>Competence</td>
<td></td>
<td>0%</td>
<td>–</td>
<td>33%*</td>
<td>–</td>
<td>20%</td>
</tr>
<tr>
<td>Relatedness</td>
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<td>–</td>
<td>67%*</td>
<td>–</td>
<td>39%</td>
</tr>
<tr>
<td>Autonomy</td>
<td></td>
<td>0%</td>
<td>–</td>
<td>67%*</td>
<td>–</td>
<td>39%</td>
</tr>
</tbody>
</table>

* Alexander and Carter not prompted for bottom moments.

moments were about getting a low score for a test or evaluation, hindering his sense of competence.

None of the men of color shared aspiring for a similar position in another organization. However, Alexander (Hispanic or Latino), Carter, and Mason (both Hispanic or Latino & White) had decided to leave engineering. Alexander and Carter were planning change, looking for more impact or meaning in their work in either advancing environmental improvement or working more closely with people.

I enjoy engineering, but [...] it’s not my ‘calling’, so to speak. Do I love building things? Yes, I do. Do I love being a part of the leading edge of technology, for goodness’ sake? Yes. But is that what my whole life is going to be about? No, I don’t think I want to be an employee my whole life. (Alexander)

Mason expressed planning to continue paying off loans, then pursuing a dual master’s, and then do something a little bit more entrepreneurial, like joining a startup or developing their own idea.

The top moments of these three engineers primarily reflected instances of feeling successful. Like White women engineers pursuing a different position in their organization and the woman leaving for a similar position, they enjoyed first-time achievements, supporting competence. Additionally, they celebrated good collaboration experiences (relatedness), moments of learning (competence), and seeing their creations or adding a personal touch to them, supporting both competence and autonomy.

Interestingly, despite their intention of leaving, several top moments were about feeling like they belonged, such as organizing a company trip or becoming the inclusion and diversity lead, facilitating relatedness, and receiving recognition from superiors, enhancing competence and relatedness. Indeed, the top moments of men of color leaving for a different position were frequently connected to autonomy (67%), unlike White men and women leaving engineering, who did not report such examples. Only Mason was asked about his bottom moments; his experiences described lamenting long weekend shifts, working overtime, and siloed communication.

**Women of color in early-career engineering**

Olivia, who identified as Asian or Asian American & White, mentioned wanting to stay in the same position (Table 8) to continue doing the work she loves.

I think that I’ve found […] the little niche that I’m very interested in, […] I really like the ownership that I have at my current company, […] as just someone who just got out of college, so I think that that makes me want to stay there. (Olivia)
Table 8. Distribution of meaningful moments across innate needs for women of color per career pathway.

<table>
<thead>
<tr>
<th></th>
<th>Stay (1)</th>
<th>Advance (1)</th>
<th>Switch (1)</th>
<th>Leave (1)</th>
<th>Unsure (0)</th>
<th>All (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supporting Competence</td>
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<td>100%</td>
<td>67%</td>
<td>33%</td>
<td>–</td>
<td>56%</td>
</tr>
<tr>
<td>Relatedness</td>
<td>100%</td>
<td>50%</td>
<td>67%</td>
<td>100%</td>
<td>–</td>
<td>78%</td>
</tr>
<tr>
<td>Autonomy</td>
<td>0%</td>
<td>0%</td>
<td>33%</td>
<td>67%</td>
<td>–</td>
<td>33%</td>
</tr>
<tr>
<td>Hindering Competence</td>
<td>–</td>
<td>100%</td>
<td>0%</td>
<td>–</td>
<td>33%</td>
<td>33%</td>
</tr>
<tr>
<td>Relatedness</td>
<td>–</td>
<td>100%</td>
<td>50%</td>
<td>–</td>
<td>67%</td>
<td>–</td>
</tr>
<tr>
<td>Autonomy</td>
<td>–</td>
<td>0%</td>
<td>50%</td>
<td>–</td>
<td>33%</td>
<td>–</td>
</tr>
</tbody>
</table>

*Brooklyn not prompted for bottom moments.

Olivia shared only one meaningful moment, a relatedness-enhancing experience of making connections at a conference she could attend as part of her work.

Same as White women, additional schooling was brought up as a way to stay in the company and pursue a different role by Isabella, an Asian or Asian American woman.

As of now, I think I’d like to keep doing consulting. The way that our program works is that after two-to-three years, generally, people go to business school, so I guess if we’re looking at a five-year span, ideally, I’d like to be finishing off my MBA. (Isabella)

Isabella shared two top moments supporting competence of being appreciated by her manager and one experience hindering competence and relatedness, describing an e-mail not being sent due to VPN issues resulting in looking bad in front of colleagues.

Aiming for a similar position at a different company was shared by Julia, a Hispanic or Latina woman, who lamented not having sufficient ownership and opportunities in her current larger organization and hoped to find this at a smaller company. Her top moments were first-time achievements and being appreciated. For example, receiving a promotion and more privileges enhanced all innate needs:

Originally, I was managing one of our teams […], and they really didn’t have the bandwidth to complete the project, so I asked to take it on and be the full-time project lead on it, and it was assigned to me. And I was still able to meet all the deadlines. […] When they let me have the project, that was nice, because that meant they trusted me to do it. (Julia)

She also described bottom moments of being sent back and forth between reviewers and working with people being opaque, hindering autonomy.

Finally, Brooklyn, a woman identifying as Black or African American & Hispanic or Latina, had already left her engineering job for a new one with more challenges. Brooklyn was only prompted for top moments; these all revolved around learning: having colleagues interested in learning, figuring out with her manager what next to work on to keep learning, and learning from a project enhancing all innate needs:

So, one of my teammates […] took a leave of absence for like three months, so, then, I took over everything that she was doing. […] And so, it was kind of scary because I was like, ‘This is a huge project, and I haven’t done anything on my own like this.’ But it was also very exciting to have all this responsibility, and then work on the project, and then kind of have ownership, and be working with all these different people that I wouldn’t be interacting with before. (Brooklyn)

**Discussion**

Based on 33 interviews of early-career engineers working in organizations across the United States, the current study investigated what engineers experience as meaningful moments,
making sense of them using the innate needs framework, and how these moments relate to whether they intend to stay or leave their role or organization. We specifically examined whether any differences could be seen across engineers identifying as White men, White women, men of color, or women of color, with gender and race representing prominent characteristics connected to early-career socialization experiences of engineers.

The meaningful moments reported by early-career engineers connected to the innate needs of competence and relatedness far more frequently than to autonomy. Also, the results suggest that intersections of gender and race influence the accessibility of opportunities supporting effectiveness and validation at the workplace. As such, the current study highlights the role of effectiveness and the significance of social validation in shaping early-career experiences, explaining differences across the groups for leaving positions, organizations, or the field of engineering altogether, so-called tipping points.

**Effectiveness as a critical dimension for meaningful work**

First, the results portray effectiveness as a critical source of meaning to early-career engineers, especially White men. Many bottom moments, even if related to negative social interactions, were described in relation to inefficiencies and ineffectiveness they caused on the job, such as wasted resources or stalled processes. Indeed, previous studies have found efficiency and improving cost-effectiveness important aspects of engineers’ identities. The current study confirms that efficiency may be a dominant discussion in engineering. Pursuing effectiveness provided meaning at work, and failure to reach effective solutions and operations undermined the innate needs of early-career engineers.

Importantly, effectiveness-related experiences were connected to different innate needs and made sense of in different ways for groups of varying representation in engineering. For all men, most bottom moments described work not going according to plan, impacting competence, whereas for women, efficiency-related bottom moments impacted relatedness more often. For White women, this resulted from working overtime or feeling embarrassed after making a mistake, and for women of color due to communication issues.

The meaningfulness of effectiveness was also emphasized in top moments on the job, most commonly revolving around seeing results, achieving an impact, and advancing new solutions through one’s work. These experiences typically made sense through the lens of either ‘market value’ within the organization or novel creations for the men of color and White women, whereas the women of color and White men coupled internal market value or competitiveness more often with social recognition within the organization. For women of color, these moments were most commonly framed as receiving validation from their superiors, whereas for White men bonding moments of being praised and recognized were more pronounced.

**Social validation as a critical dimension for meaningful work**

Second, social interactions and the social setting of work were front and center in most meaningful moments reported by virtually all early-career engineers. Past studies show that more than half of engineering time involves interactions with others in more experienced engineering positions, and other early-career engineering studies confirm communication-related activities are prominent from the very start. Our results highlight
the impact of the quality of these interactions. Examining the negative experiences of early-career engineers on the job, adverse social conditions were often connected to hindering the innate needs of not only relatedness but competence and autonomy as well. For example, many engineers shared team and peer issues, such as failing publicly, lacking support or trust, and communication issues. Similarly, positive social interactions could boost all innate needs, creating more innately rewarding and meaningful work experiences. Indeed, previous research suggests that teamwork can be a highly valued aspect of engineering jobs.38

The current study extends this by identifying salient types of interactions around receiving recognition or lack thereof.

Given the meaningfulness of social interactions, it is worrying that a clear distinction emerged across gender and race lines in how the early-career engineers experienced relatedness at their jobs. White men shared an abundance of top moments enhancing their relatedness (67%), describing moments of positive recognition and within-organization fame primarily, and were more likely to report higher and broader levels of recognition, celebrating becoming the ‘go-to-guy’, getting superiors excited about their ideas, and receiving early promotions. In contrast, men of color shared informal events supporting their relatedness, such as a welcoming training, a camping trip, or receiving a gift card (with 50% of their reported top moments enhancing relatedness). For White women, in contrast, moments enhancing relatedness were far less common (35%). Those moments described more personal relationships, such as having supportive colleagues or being appreciated by peers for their work output. For women of color, although 78 percent of top moments were connected to relatedness, none were about bonding, but rather they focused on receiving recognition and learning experiences.

Conversely, relatively few bottom moments of men undermined relatedness (39% for White men and 20% for men of color), usually describing communication issues. For women, many of their bottom moments reported concerns of a negative reputation impacting their sense of relatedness (63% for White women and 67% for women of color) – for example, when making a mistake or being subjected to inappropriate behavior. Indeed, social categorization39 may contribute to these early-career experiences. In this social process, actors at the workplace draw distinctions between ‘us’, with whom the categorizer identifies as similar, and dissimilar ‘others’.40 Being relatively visibly expressed characteristics, gender, and race are prevalent bases for ‘ingrouping’ and ‘outgrouping’ people.41 In this context, White and man are bases for ‘ingrouping’. Outgrouping can lead to less information sharing42 and poorer connections to supervisors and peers.43 Our findings of differential recognition within organizations support existing notions of likely to be out-grouped people facing more obstacles to contribute, as their social identity and novel perspectives connect less with dominant cultures.44

Staying or leaving, what are tipping points for leaving the organization?

Early-career engineers intending to stay in their current organization reasoned that this would allow them to grow their expertise and increase their responsibility, thus increasing the ability for and extent of impact they could have. In general, career plans were rarely attributed to any specific instance of social interaction. Still, the sum of early experiences affected the engineers’ perceptions of what was possible and welcomed in the organizations. Surprisingly, engineers intending to stay in their current positions reported some of
the most vivid experiences of interpersonal conflict. Yet, these isolated events were outweighed by positive experiences of recognition, collective enthusiasm, or impacting the organization – all factors that can reaffirm one’s identity as an engineer.\footnote{45}

On the other hand, different experiences on the job seemed to lead to different perceived career pathways available for advancing within the organization. White men looking to advance their careers turned towards internal advancement opportunities building on reputation and relatedness experiences, whereas White women, as well as the Asian or Asian American man and woman looking to advance, highlighted moments of competence at work and sought external credentials to enable advancement. Here, differences in experiences affecting relatedness were particularly pronounced, with White men reporting mainly positive experiences enhancing relatedness about bonding with colleagues. In contrast, White women shared only a few moments of experiencing supportive colleagues, with many more moments describing issues with their superiors, such as working unpaid overtime, which undermined relatedness. This is in line with earlier findings that due to women being perceived as less competent, they need to work harder to get promoted.\footnote{46}

Intentions to leave the organization also centered around impact. While advancement and negative social interactions may have contributed to the intention to leave, the moments accumulating to the tipping point were mainly attributed to the lack of effectiveness or control over the scope of work in their current positions. Those looking for a similar position in another type of organization all hoped that the change would provide more access to opportunities to meaningfully contribute in their line of work, for example, by working in a smaller organization. While reasons for looking for a different type of position in another organization were more varied, these also focused on seeking opportunities to work on more meaningful issues or have more ownership in one’s work. Usually, these engineers expressed feeling good about their work, not about the resistance they received.

For engineers intending to leave the organization, White men were more focused on increasing their impact irrespective of the industry or challenge they were working on, often linked to a startup, in line with their top moments of being treated like a valued resource. White women, in contrast, expressed wanting to do more engineering analysis and see their impact more, building on many competence-enhancing moments. Despite many top moments shared by engineers of color intending to leave, the men in this group expressed dissatisfaction with the impact they were having through their engineering work, and the women felt insufficiently challenged.

Additionally, while all engineers intending to leave their organization reported moments undermining their autonomy (most commonly due to wasted time), White men were the only group more likely to report negative experiences undermining their competence. In contrast, the other three groups shared more moments undermining relatedness. Here, in addition to differences in prevalence, more intensive experiences could be seen amongst these engineers more likely to be outgrouped at the workplace: while White men more often lamented ideas being resisted, White women shared negative experiences of unintentionally offending a colleague, men of color felt hindered by siloed communication, and women of color shared a variety of collaboration issues. This supports findings in previous research, with, for example, Frehill\footnote{47} concluding their literature review of women in engineering by stating that ‘men were more likely to leave the field for advancement opportunities or ‘other career issues’ (which included salary), but women were more likely than men to indicate they left a negative work climate,’ echoed in other studies also.\footnote{48}
Perhaps as a silver lining here is the notion that, in particular, the women engineers with the most negative social experiences – when coupled with intense positive experiences of competence on the job – did not intend to leave their organization or the field but instead saw possibilities to change their circumstances through advancement, even if through different pathways than White men peers. Indeed, other studies have shown that Black women engineers have ‘a heightened racial and gender awareness’ which can support challenging norms of a White-men dominated workplace, however also that women feel like they first need to ‘fake it’ to figure out how to create a sense of belonging and be able to participate legitimately. Yet integrating hires with new perspectives that challenge the status quo might take years before they can contribute to organizational outcomes. Additionally, previous research has shown that the first months on the job play a crucial role for newcomers, setting the tone for integration in terms of delivered – or broken – promises. It may be that being able to deliver on promises regarding effective work was able to compensate for the lack of relatedness for people of color and women engineers looking to advance in the organization. However, issues may cumulatively form a tipping point for newcomers to later withdraw from the organization, suggesting an elevated risk of people of color and/or women leaving engineering down the line due to negative early-career experiences undermining relatedness.

Practical implications
The study highlights how small moments of interaction, especially recognition, stand out from months of experience on the job. Particularly feedback from supervisors and management, such as small words of praise, were long remembered. However, White men reported more such moments than women or people of color. The data do not reveal whether White men had more of these moments or just valued and remembered them more, yet it does support that managers should be mindful of whose efforts they notice and comment on. For women or people of color, peers were more often a source of validation than managers, but they were also more often sources of undermining belonging at the workplace. Investing in facilitating interaction and collaboration can improve knowledge sharing and create a more pleasant and productive work climate.

Early-career engineers with similar career goals saw different pathways for reaching these. Women and people of color were more likely to view external credentials as necessary for advancement – organizations wishing to retain the talent they have recruited would be well served to ensure internal advancement opportunities are accessible and clear to all newcomers. Social validation and feeling effective were critical considerations for all engineers, and unclear meaning and ownership led them to look for opportunities elsewhere. Managers should strive to create roles and practices that provide greater visibility into the effects of employees’ work to support competence development and meaningfulness perceptions.

Future directions
Echoing Beddoes, more studies are needed to explore early-career experiences in various organizations, positions, and cultures. As the current research is based on cross-sectional data, longitudinal studies are required to capture how experiences influence early-career
engineers’ intentions over time. The present results suggest that social validation and perceptions of effectiveness and impact may be relevant experiences to track over time. Using a longitudinal critical incident study design like Woodrow and Guest\textsuperscript{56} could create a deeper understanding of how these experiences shape desirable and feasible career pathways.

The current study relied on self-reported data from early-career engineers’ perspectives. A limitation of this study is that the results, as mapped on the innate needs framework or the correspondence of top and bottom moments to meaningful moments, were not triangulated with the participants. Future studies might ask participants to report such moments in daily diaries to capture a wider variety of meaningful moments and assess their connections to innate needs. To further explore how social categorization processes shape access to meaningful experiences, further studies might also examine the social composition in which the early-career engineers are placed. Additionally, due to the small number of participants of color, the current study grouped engineers of various ethnicities, limiting the nuance of intersectional factors in engineering experiences. We encourage future studies to examine variations of meaningful experiences and career intentions across intersections of all races and all genders of newcomer engineers. The current results suggest that experiences of impact, effectiveness, and interactions are highly meaningful, and understanding how intersectionality in representation at the organization contributes to opportunities for these holds promise in understanding better how to support early-career engineers in their entry and retention in the field.

Notes

8. Buckley et al., “Perspectives on Engineering Education.”
11. Ibid., 159.
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Disclosure statement

No potential conflict of interest was reported by the author(s).
**Ethics statement**

Ethics approval was obtained through Stanford University Human Subjects Research Institutional Review Board (#35539), and participants were informed of their rights and the voluntary nature of the study.

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**Data availability statement**

The data are not shared due to privacy or ethical restrictions.

**References**


