I Don't FIT the Stereotype, but I see Myself as an Engineer: First-Year Engineering Students' Attitudes and Beliefs about their Engineering Identities

Brianna, Benedict, Dina Verdín, Rachel Baker, Allison Godwin, Aaron Thielmeyer
Purdue University, School of Engineering Education, West Lafayette, IN

***Abstract*—This research category *full paper* examines the attitudes and beliefs that first-year engineering students have about the stereotypes of engineers and what it means to fit in engineering. We explored the attitudes and beliefs of 12 first-year engineering students, who may or may not identify with certain aspects of the stereotypical engineer, to understand their initial perceptions of engineering and what it means to fit in engineering. Most of the students' descriptions of an engineer aligned with the widely-accepted stereotype of an engineer, but they were also careful to state that that image was not true of all engineers. Several students expressed how they fit in engineering as a matter of "sticking it out" because engineering requires hard work, motivation, and commitment, along with other attributes that were not descriptive of a stereotypical engineer. In this paper, we explore the tensions in how students describe the role of "an engineer" generally and their own identities and fit as engineers.**

Keywords—Engineering Identity; Fit; Belongingness; Agency

I. INTRODUCTION

There is a societally socialized stereotype of what it means to be an engineer and who fits in engineering—a white, nerdy man who prefers to work independently, is technically competent, and is introverted [1]. This stereotype can influence who envisions themselves as someone who can do engineering and take on that identity [2]. Despite decades of work that have been dedicated to changing the conversation about what it means to be an engineer, these stereotypes are still prevalent. There is a need to shift how engineering is perceived by the public as well as brand engineering as a community "for all … to improve the work of engineers [3, p. 2318]." This shift includes welcoming people who are diverse according to a wide array of identities such as gender, race/ethnicity, dis(ability) status, sexual orientation, interests, attitudes, and beliefs [4]. This change to include diverse populations needs to occur within the engineering culture before it is widely accepted in society. Engineering students not only believe that particular types of people "fit" in engineering, but they also shape engineering culture themselves**.**

In a simple image search of the term "engineer," the retrieved images show a narrow idea of an engineer. Most images show men and women in teams (mostly white) in hard hats. These images also show the people reading blueprints, walking construction sites, or in laboratories. Other media, like TV shows and movies, depict engineers as socially inept men who are born with the "knack" for engineering concepts and understanding "all things mechanical or electrical [5]." One popular example of this phenomenon is the CBS comedy *The Big Bang Theory*, which follows the lives and hijinks of four men who all work in STEM-related fields. The central element of this show is how all four men, while brilliant in their respective fields, are socially inept and incredibly "nerdy." These main characters from *The Big Bang Theory* frequently exhibit a lack of communication skills, an absence of social awareness, and introverted behaviors; however, these personality traits are all considered acceptable because of their various STEM professions and interests [1]. *The Big Bang Theory* is just one example of media that perpetuates the image of engineers as brilliant, introverted, hyper-logical, white men. This depiction is not only inaccurate, but it also deprives individuals from minoritized groups from proper representation and imagining themselves in STEM careers. Our work aims to promote a broader and diverse representation of an engineer beyond the "hard hat" image of engineers as they appear in media.

This paper focuses on how students described what it means to fit in engineering. The students interviewed for this project recognized that there is a socialized stereotype of an engineer; however, their atypical narratives push against the cultural norms of engineering by transforming what it means to "fit" in engineering. Prior work has shown that students describe their male peers as the "poster child" of engineering because they align with the socialized stereotype of an engineer [6]. However, this notion of an ideal engineer did not diminish their sense of belonging [6]. Instead, we describe how students are resisting societal and institutional structures of "what counts" and "who belongs" in engineering [6]. This work further supports the idea that students are constructing a counter-narrative of what it means to fit into the culture of engineering. Understanding these counter-narratives and identity negotiations can provide ways to support diverse students' integration into engineering.

II. THEORETICAL FRAMEWORK

A. Socialized Stereotype of an Engineer

For decades, engineering has been a "prototypical masculine profession" [7, p. 351], specifically defined by a

This work was supported by the National Science Foundation, CAREER grant number 1554057. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

978-1-5386-1174-6/18/$31.00 ©2018 IEEE

white, Western male perspective. Being an engineer requires an individual to "look like an engineer, talk like an engineer, and act like an engineer" [7, p. 355]; there is an implicit assumption in engineering about who can be and who is recognized as an engineer. While first-year engineering students may enter the field with a variety of engineering and/or STEM identities, these identities are not fixed, rather they are "a product of historically specific practices of social regulation" [8, p. 79]. In navigating the culture of engineering, the construction of these identities becomes a negotiation process where certain characteristics or identities become "left out." These identities are then *otherized*, which has the potential to hinder the formation of an engineering identity for certain individuals [8]. Students often negotiate who they are by the future identities of who they wish to become (i.e., an engineer) through experiences they have within the culture of engineering. Prior work has documented that the culture of engineering conforms to social norms of masculinity [9]. These masculine characteristics, as described by Cejka and Eagly [10], include personality traits (i.e., competitive, daring, dominant, adventurous, aggressive, courageous, stands up under pressure) and cognitive traits (i.e., analytical, mathematical, exact, quantitatively skilled, and good at reasoning, abstractions and problem solving). The masculine cognitive traits described by Cejka and Eagly [10] are in line with the seminal work of Godfrey and Parker [2], which described cultural dimensions of engineering to include *engineering ways of thinking* (i.e., thinking in mathematical terms and problem solving) and engineering ways of doing (i.e., "hard" and "challenging" or their synonyms "tough," "difficult," "demanding," were extremely frequent, with a common acknowledgement of a very heavy workload") [2, p. 12]. These cultural dimensions of engineering form an implicit assertion of who fits into engineering. That is, to feel as if one belongs in engineering, one must take on the masculine cognitive traits of engineering ways of thinking and ways of doing.

B. The Tension between Belonging and Fit

A sense of belonging is a fundamental human need [11]. However, we posit that a sense of belonging cannot be established if students' do not *fit* within the institutional and disciplinary cultural norms. Research studies often implicitly use belonging and fit interchangeably. A recent study, using a cross-sectional design, determined that belonging mediated the effect of person-environment fit on well-being, academic motivation, and persistence [12]. In our study, we use the model from Holland's [12] work which states that person-environment fit precedes a sense of belonging. Person-environment fit is a theory of individuals' personality types as it relates to, or diverges from, their environment [13], [14]. In this theory, there are six types (i.e., realistic, investigative, artistic, social, enterprising, and conventional) of personalities that are based on patterns of attributes such as interest in certain activities, one's values, how an individual sees him/herself (identity), and attributes one wishes to avoid [13]. Each personality type and pattern of attributes are attracted to specific environments [8]. Person-environment fit assumes that an individual's achievement "is a function of the congruence or 'fit' between their personality type, attributes, and their environment" [13, p. 643], [15]. Additionally, when there is congruence between the individual's personality type, attribute, and environment, there is an overall "job satisfaction, stability of career path, and achievement" [13]. [12] applied the theory of person-environment fit to undergraduate students and found that congruence between the students' perceptions of who they are (personality type) and the university cultural norms (environment) significantly predicted a sense of belonging to the university. While prior work has examined students' sense of self in much broader terms than personality [4], this same idea of fit as determined by the congruence of an individual's values and characteristics within their environment is useful in understanding how students may experience and perceive engineering.

We understand a sense of belonging through the work of Strayhorn [16], which described a sense of belonging as "perceived social support on campus, a feeling or sensation of connectedness, the experiences of mattering or feeling cared about, accepted, respected, valued by, and important to the group (e.g., campus community) or others on campus (e.g., faculty, peers)" [p. 17]. A sense of belonging focuses on establishing membership and connectedness within a student's institution. Our prior work has also found that beliefs about seeing oneself as the type of person that can be an engineer had a positive effect on students' sense of belonging in the engineering field and classroom [17]. While another study examining students' future perceptions of themselves as engineers found that a sense of belonging accounted for the most variance explained in students taking on the identity of being an engineer [18].

C. Structure and Agency

Agency can be understood on a surface level through associated terms such as: will, purposiveness, intentionality, choice, initiative, freedom, and creativity [19]. Agency is the exercise or manifestation of an individual's capacity to act [20]. Agency is presumed to be present in all fundamental human actions, every individual (actor) possess agentic (or internal behaviors) capabilities and can exercise these capabilities at any time. Enacting agency affords students the ability to "remake the world in which they live" [21, p. 48].

Individuals possess varying degrees of capabilities and in turn, they possess varying perceptions of agentic potential. Agency is a behavior through interaction between the self, environment, social structures, power relations, and discourses. Agency situates the individual (actor) in a "historically contingent, socially enacted, culturally constructed 'worlds'" [21]. Historically contingent refers to cultural identities an individual brings to each interaction, the interaction being the social space where these cultural identities are enacted, and where culturally constructed worlds pertain to an individual's figured world (e.g., engineering classrooms or the field of engineering). Individuals actively shape their surroundings while at the same time, these surroundings shape the individuals [22], [23]. For example, engineering students are simultaneously shaped by the culture of engineering (i.e., engineering ways of thinking and knowing) and can refute some of these cultural norms and begin to reshape what is considered engineering to them.

D. Authoring Identities as Engineers

Students author identities as engineers through a negotiation process of seeing themselves as the type of person that can do engineering (enacting agency) and navigate through the cultural norms of what it means to be an engineer (historically contingent, culturally constructed figured worlds [21]). These structures also inform the socially constructed stereotypes of what it means to be an engineer. Together the structures and culture shape what it means to be an engineer and students respond to those implicit and explicit messages. Students may experience a mismatch between their own selves and the structures of engineering resulting in a lack of fit. However, they may also enact agency in shaping their own identities in relation to those structures. In doing so, they can reshape the stereotype to redefine what it means to be an engineer *for them*. This process of redefining and authoring an identity as an engineer promotes a sense of belonging [17], [18]. In turn, belonging matters to promote academic engagement [24], motivation and persistence [25], and grit [17].

III. Methods

The goal of this research is to understand the incoming attitudes of students in engineering and how that might create opportunities to enact agency to redefine the role of what it means to be an engineer. We answer the following research questions, 1) How do students describe what it means to "fit" into engineering? and 2) How do these definitions influence who fits in engineering for both themselves and their peers? We are not concerned with generalizing their experiences in engineering. Instead, we are interested in telling the stories of how those students navigate an engineering culture that persists to be exclusive to diverse ways of being an engineer.

A. Overview

We recruited twelve first-year engineering students at a large Midwestern university based on their completion of an attitudinal survey in Fall 2015. A semi-structured interview protocol was used to conduct an hour-long interview with each student in Fall 2016. The semi-structured interview protocol was designed to elicit responses about the students' pathways into engineering, identity, belongingness, and lived experiences. This research study focused on students' responses to the following interview questions 1) "What makes a person fit in engineering?" 2) "What does it mean to fit into engineering?" and 3) "Describe whether engineering is a good fit for your friends or the people you associate with." We present students' self-identified demographics (see Table I) and the analysis procedure in more detail below.

B. Participants

We purposefully selected students to maximize the number of women, students of color, first-generation college students, LGBTQ+ students, and students with visible and non-visible disabilities. These students represent a wide variety of experiences and backgrounds within engineering education. In addition to diversity among social identities, we recruited participants based on their voluntary participation in an attitudinal survey, per the overview description. The demographics shown below in Table I are self-identified. Each student selected their own pseudonym to protect their anonymity; however, in some cases, the students requested the researcher to select a pseudonym. The voices of all students are represented in the findings reported in the results section below. Most of our participants (n = 7) identified as women—Naomi, Anika, Ayida, Ashley, Casey, Penny, and Jean. The remainder of our participants (n = 5) identified as men—Richard, Nick, Kevin, Nathan, and Mr. Rhee. Students also came from different engineering disciplines as shown in Table II.

TABLE I. STUDENTS' SELF-REPORT DEMOGRAPHICS.

Demographics		**Count**	
		Men	**Women**
Race/Ethnicity	African-American	1	1
	African-American/ Caribbean American	-	1
	Asian (Chinese, Indian, Vietnamese)	1	2
	Latina	-	1
	White	1	2
	Peruvian-American	1	-
	Turkish	1	-
Visible and Non-Visible Disability		1	1
1st Generation College Student		1	3
LGBTQ+ Student		1	-
International Student		-	1

TABLE II. STUDENTS' PSEUDONYMS AND ENGINEERING DISCIPLINES

Pseudonym	**Discipline**
Naomi	Agricultural and Biological
Casey, Penny, Jean	Industrial
Ayida	Aeronautical
Nathan, Richard, Kevin	Mechanical
Ashley	Biological
Anika, Mr. Rhee	Electrical and Computer
Nick	Civil

C. Analysis

The interviews were audio recorded and transcribed verbatim. A team of researchers, both undergraduate and graduate students, used inductive constant comparative method to synthesize students' experiences regarding their beliefs about engineering and what it means to fit engineering across all our participants. The primary aim of our research is to understand how students describe what it means to fit in engineering and whether engineering is a good fit for themselves or their peers. Therefore, this open-coding approach allowed the overarching themes to emerge organically without a theoretical lens guiding our analysis.

IV. Results

This paper reports how our students describe what it means to fit in engineering. We identified three themes that connect to our conceptual frameworks focusing on how students acknowledge a socialized stereotype; however, they exercise their agency to redefine how they fit in engineering. These ideas encompass 1) students' agency in pushing against traditional stereotypes of engineers, 2) the rigor culture persists, but students' use community to overcome the struggle, and 3) engineering requires a diverse set of skills that can be achieved by all students in different capacities.

A. *Fake News: Stereotypes of Engineers in the Media*

Two students, Casey and Penny, described how the public perception of an engineer is a "nerdy, white guy with glasses on" who is "socially awkward" and secludes himself from others. In addition to this limiting and often incorrect stereotype that the students described, students also discussed how engineering is often associated with a student's mathematics and science achievement over anything else. Naomi shared how the university standard of a "good engineer" contradicted the value of people like her grandfather and father who naturally have "the brain of an engineer." When asked whether fit was associated with class performance, she said:

> I think that's the way it should be. I just feel, maybe it's not necessarily how it is here, but right now, since I'm retaking a class, I feel like how good of an engineer I'm going to be is how well I can do in my classes right now and if I can bring my GPA back up. Like I said before, sometimes, like with my grandpa, he just had the brain of an engineer. I guess it's more of being a really good engineer it doesn't really depend on your classes, but right now that's all I can think about.

Similar to Naomi's description of characteristics associated with "the brain of an engineer," two other students described how it is important for engineers to be dedicated to lifelong learning and willing to learn outside of the classroom. Ashley described how some of her peers were a good fit for engineering because they do not define success according to a letter grade:

> I see them just because they don't like those yes or no answers. They want more in-depth and when they don't understand something they will go seek an SI (Supplemental Instructor) or seek the professor or they'll go seek some YouTube video or Khan Academy or something. And then some of my friends are just kind of more content I don't mind and they're just going through the motions and they figure success with that letter grade and not necessarily what you're going to pull out and retain for the future.

The National Academy of Engineering (NAE) conducted a research study to identify productive and authentic messages to improve the public perception of engineering to messages such as "engineers make a world of difference" to improve how people perceive engineering [26, p. 79]. In addition to identifying authentic and positive perceptions of engineering, their study identified how the perceived difficulty of mathematics and science intimidates students from joining engineering since they are not aware of the creative aspect of engineering or are not "smart enough" to be engineers [26]. Although mathematics and science concepts are important to understanding engineering, it is important to acknowledge the diverse ways of being an engineer. Major national reports and accrediting boards [26], [27] recognize the importance of having a mindset to "acquire and apply new knowledge [27]" as an essential part of being a successful engineer. Additional attributes that are important in engineering, but are often not present in the traditional stereotypes described by students in our study include the importance of teamwork and communication, in order to fit into engineering [27]. These student experiences highlight the importance to ask questions like "Who counts" and "What ought to count" [28]. Instead of continuously reiterating the narrow perceptions of an engineer or engineering, the invisible necessities of being an engineer should be recognized to improve how students identify and fit in engineering.

B. *The Gauntlet: Survival of the fittest through collaboration*

According to Penny, the culture of engineering is associated with "sticking it out." She described how the upperclassmen shared the need to "push through" and how "it will be worth it in the end." Kevin also described how a "rigorous course load" is associated with engineering; however, one can persist if they are "committed to it" and "willing to go through with it." His reference to "it" pertains to engineering and further supports Riley's [28] work that continues a conversation about rigor being a "weapon to destroy all knowledge epistemologies, as well its "central role to academic survival" [p. 257]. She also discussed how the rigor culture is limiting and not inclusive to diverse ways of knowing [28]. This notion of rigor influences who believe they fit in engineering, as well as an attitude that "harder is better" [28, p. 259]. This belief that engineering is "hard," "difficult," or "demanding" is a narrative that persists in the culture of engineering [2]. More importantly, the attitude that students' should "stick it out" is identical to the message that students should just "work through the pain," which is often associated with masculinity [2]. Despite this enduring attitude about engineering, some students describe "rigor" like an inherent aspect of being an engineer; however, these students acknowledged how fitting in is based on being "a part of the team" and/ or sense of community.

Students' willingness to "stick it out" was not based on undertaking the engineering path alone. Six students described how "fit" was associated with identifying a sense of community among their engineering peers or seeking out help from others. For example, Ayida described how her peers are a good fit for engineering because of their interest in solving problems and their willingness to help one another:

> You walk in the kitchen [at sorority house], every girl is competing with each other trying to get the puzzle right. It's a problem and you're solving it. That's what they're always trying to do, solve problems, which is why I think they'll be really good engineers. When you come in the afternoon, they're helping each other with homework and you're like, "That's why." They're helping each other build things.

Some students may not live in communities where they readily have access to their engineering peers; however, Ashley suggested how it is important to be "open-minded" and willing to "communicate with other people" to figure out what one does not know. Similarly, Mr. Rhee described what it meant to fit based on being "part of a team," otherwise students would feel "isolated if you can't communicate with people and work with them." Another student, Nick, described how fit is also contingent on acceptance:

> I think it means to like understand and to feel accepted, like a combination of your past two questions. Like I could enjoy it all the time but if I was being discriminated against based on anything then I wouldn't feel like I fit in.

Nick's description of fit aligns with the need to belong and the value of engineering being an inclusive culture to combat exclusive messages associated with rigor. This notion of acceptance to fit in was found by Godfrey and Parker [2] and necessary for academic success, in order to master the shared hardship.

The students' experiences consistently re-authored the socialized stereotype of an engineer by highlighting the significance of collaboration for survival. There was a case where one student alluded the need for doing or "studying engineering" to be "natural" or you would not fit in. Otherwise, the students were concerned with merely "surviving" and the need to "finding your home" or "place" was just as important as coursework achievement. This notion of survival through collaboration does not align with the public perception of a secluded nerd.

Although the students acknowledged that there is a university standard and public perception of what it means to be a good engineer, they were willing and committed to surviving the "gauntlet" of engineering that was shaped by their negative experiences in a weed out competitive culture by collaborating with their peers. Their decision to share the hardship does not erase the fact that the rigor culture in engineering persists. It is a marker that shows how the engineering culture is dated and needs to change. These student experiences highlight the importance of investigating ways students can be recognized as an engineer that is not solely defined by their ability to "survive," as well as examine how the "rigor" culture is limiting their ability to be creative and innovative and form enduring engineering identities.

C. *You don't have to be good at everything: Engineering has space for everyone*

Some of the students acknowledged how mathematics is an important subject related to success in engineering; however, students also described the value of a passion, strong work ethic, interests, and confidence in what it meant to fit in engineering. Contrary to the socialized stereotype of an engineer, Nathan described how "you don't have to be super-tech to be an engineer" or "super good at idea generation." He believed that there are several facets of engineering that are important to be a successful engineer and that one did not need to be good at all of them to be an engineer. Prior to defining the diverse ways someone can be an engineer, Nathan dismissed the institutional structure that define "what counts as engineering" and defined his own meaning of what counts by describing how "poly-tech people do more engineering than actual engineers because they actually make the system work. We just design it." Nathan also described how students fit into engineering based on their ability to work with their hands. However, he proceeded with stating how he "wondered if that counts as engineering." He continued describing various attributes of engineering such as thinking about how users intend on using the product, being good at communicating with users, testing the quality of the product with users, designing products according to technical requirements, developing products for user aesthetic preferences, or manufacturing products. Nathan believed that engineering was a wide enough field with varied facets that "there is a slot for you" if you achieve (but not all) skills needed in engineering. According to Nathan's definition of engineering, students do not have to encompass each attribute described. Instead, students should decide what "type of engineer" they want to be based on some of the attributes described above, as opposed to focusing on a specific engineering discipline informing whether they fit in engineering.

Other students described how engineering is diverse and fitting in was a matter of being interested in engineering and "feeling comfortable." Four students described how students who pursue engineering must have a particular mindset to fit in engineering. Kevin believed that students fit in engineering based on their drive to "help human life" through engineering. Similarly, Casey described how students fit in engineering based on their mindset to "improve things", as well as, "I think questioning processes and just being able to analyze data and situation, really give you the engineering skills." In addition to continuous improvement, Ayida described the value of finding the best answer for the problem being posed:

> The best way I think to fit in as an engineer is to have your ideas and to believe and be able to defend your ideas, not just agree with what has been defined as right. Sometimes what's right could actually be wrong, and you didn't know it.

Naomi described a complementary idea to Ayida's description of problem scoping. She believed that a student needed to be confident in their ability to be an engineer:

> I always told my mom that I felt like the really successful people here were very confident in themselves. To fit in engineering, I think you have to think that you're the best, to some degree. Not that your ideas are always the best. I always said it's really hard to be an engineering student at this university if you don't believe in yourself 100%. That's why I felt like last year I didn't really believe in myself. I didn't believe that I could do it. That's why I struggled.

The students' experiences suggest that the "struggle" is inevitable at their university. However, the students believe that engineering is not a matter of knowing all things, instead, one must find where they fit in.

V. Discussion

The purpose of this paper is to understand how first-year engineering students describe what it means to fit in engineering and whether their peers fit in engineering regarding their description. We identified three themes to explain students' attitudes and beliefs about engineering identities. These ideas comprise 1) students' agency in pushing against traditional stereotypes of engineers, 2) the rigor culture persists, but students' use community to

overcome the struggle, and 3) engineering requires a diverse set of skills that can be achieved by all students in different capacities.

Students acknowledged the priority of mathematics and science achievement when asked about what it means to fit in engineering. However, the students also discussed how being a good engineer is based on more than class performance. Instead, the students described how their peers who sought information outside of the classroom fit more in engineering, as opposed to their peers who were satisfied with going "through the motions" and defining success with a letter grade. Prior work has shown how privileging mathematics and science can limit who decides to pursue engineering as a career [26]. These findings show how students have their own way of defining "what counts" as an engineer; however, the students were limited by what is valued by the dominant culture.

Several students described how engineering is rigorous; however, an engineering student could overcome the difficulty of engineering with community, acceptance, and commitment. The students described how being a "part of the team" is what makes someone fit in engineering. Prior work has shown how establishing a sense of belonging and acceptance is necessary for academic success in engineering [2], as well as how students take pride in the belief of "shared hardship" [p. 12]. Although the students have found a way to overcome the rigor culture, our work highlights the need to follow-up on Riley's [28] work with regard to attitudes of rigor that potentially exclude diverse ways of knowing and being an engineer.

These students also found value in communication skills to work with their peers to advance their engineering knowledge. Students described some ways of fitting in engineering such as an aim to improve processes and make a difference. These beliefs are similar to prior work that discuss why students pursue engineering as a career pathway [29], [30]. One student, Nathan, defined fit by describing how there was no need to identify with every aspect of the field; however, he also acknowledged how that engineering skills and attitudes taught in the engineering classroom may not set one up for success in engineering post-graduation. He felt that students who fit the stereotype of engineering may not be as successful as other students in their pathways. Although these students did not take on the socialized stereotypical identity of an engineer and authored identities that made them fit as engineers, the students' beliefs about what it meant to fit in engineering did not acknowledge additional ways of knowing that are common in fields such as social science or ethics. While these students enacted agency to reshape the stereotypes of engineering that allowed them to fit within the engineering culture, they did not challenge the fundamental assumptions of the culture itself. This finding illustrates how students may buy into the norms and culture of engineering [28]. Students along with other individuals like faculty, administrators, and staff continue to reify a culture of engineering that can be exclusive to particular groups of people or individuals with particular ways of thinking and knowing in engineering [31].

In investigating student beliefs about what it means to be an engineer, we have captured a snapshot of the current culture of engineering. This description of how students navigate and author their identities as engineers' counter to but also in alignment with the culture and stereotypes of engineers can provide ways to create a space for minoritized groups to pursue engineering. One factor in broadening the stereotype of an engineer is encouraging positive representations of engineers in media like TV shows and movies. Where some examples like *The Big Bang Theory* may fall short, other examples like Marvel's *Black Panther* provide a more positive role model for engineering professionals [32]. Shuri, a central character in the 2018 movie, is a technical genius who develops all the incredibly advanced machinery and technology in the world of Wakanda. Not only is Shuri shown to be a brilliant inventor and engineer, she is also outgoing and collaborative. As a young, black, female prodigy, she is treated with the utmost respect as she exhibits her impressive knowledge through her revolutionary inventions. However, her intelligence is never used to intimidate or belittle others, and she is shown to be quick to include others and ask her peers for help when needed. Representations of engineers like Shuri in media exhibit the diverse and collaborative future of engineering. Depicting positive STEM role models for children and students who may not otherwise see themselves represented in engineering, characters like Shuri offer hope and opportunity.

In this paper, we have highlighted how students' descriptions of engineering stereotypes interface with their identity development as engineers in complex and multifaceted ways. Students exhibited agency to author identities in contrast to typical stereotypes about engineers through pushing against norms portrayed in the media; however, they also confirmed to much of the issues documented in the rigor culture of engineering. Students also described how they fit in engineering by focusing on their strengths and building strong networks among their peers. Our work begins to show particular ways that faculty may push against the cultural norms of engineering and empower students to author identities as engineers.

VI. Conclusion

These research findings highlight how students describe what it means to fit in engineering and who fits in engineering. They described what it meant to fit in engineering that is not aligned with the socialized stereotype of an engineer; however, the students highlight how there is a narrow perception of "what counts" in engineering. Our work highlights the need for the culture of engineering to acknowledge diverse ways of being an engineer, especially as we begin to revisit what we want the 2040 engineer to know and do to solve issues across several contexts that require students to explore boundaries that are not perceived as rigorous to make a difference in our world. The agenda of these conversations should intentionally discuss the value of inclusion regarding ways of knowing, thinking, and being an engineer. Our future work includes continued exploration of how students author their engineering identities, in hopes to further understand who and what is recognized as engineer or

engineering. We aspire for students to not only simply "get through" engineering coursework, but also transition into the workforce and someday inspire the next generation of students to pursue a career in engineering.

ACKNOWLEDGMENT

The authors wish to thank the STRIDE research group and the interview participants for their participation in the study.

REFERENCES

[1] R. Mccord and V. Tech, "Bazinga! You're an engineer. . .you're ! A Qualitative Study on the Media and Perceptions of Engineers," in *ASEE Annual Conference and Exposition*, 2013, p. 23.240.

[2] E. Godfrey and L. Parker, "Mapping the Cultural Landscape in," *J. Eng. Educ.*, vol. 99, pp. 5–22, 2010.

[3] M. Hynes, C. Joslyn, A. Hira, J. J. Holly, and N. Jubelt, "Exploring Diverse Pre-College Students' Interests and Understandings of Engineering to Promote Engineering Education for All," *Int. J. Eng. Educ.*, vol. 35, no. 2B, pp. 2318–2327, 2016.

[4] A. Godwin, "Unpacking Latent Diversity," in *ASEE Annual Conference and Exposition*, 2017.

[5] S. Adams and L. Charles, *Dilbert- The Knack "The Curse of the Engineer."* Standard YouTube License, 1999.

[6] B. Benedict, D. Verdín, R. A. Baker, A. Godwin, and T. Milton, "Uncovering Latent Diversity: Steps Towards Understanding 'What Counts' and 'Who Belongs' in Engineering Culture," in *2018 ASEE Annual Conference & Exposition*, 2018.

[7] J. Jorgenson, "Engineering selves negotiating gender and identity in technical work," *Manag. Commun. Q.*, vol. 15, no. 3, pp. 350–380, 2002.

[8] M. Walker, "British Journal of Sociology of Education Engineering Identities," vol. 5692, no. December 2013, pp. 37–41, 2001.

[9] U. M. Akpanudo, J. L. Huff, and A. Godwin, "Hidden in Plain Sight : Masculine Social Norms in Engineering Education," in *Frontiers in Education Conference*, 2017.

[10] M. A. Cejka and A. H. Eagly, "Gender-Stereotypic Images of Occupations Correspond to the Sex Segregation of Employment," *Personal. Soc. Psychol. Bull.*, vol. 25, no. 4, pp. 413–423, 1999.

[11] R. F. Baumeister and M. R. Leary, "The Need To Belong - Desire for Interpersonal Attachments as a Fundamental Human-Motivation," *Psychol. Bull.*, vol. 117, no. 3, pp. 497–529, 1995.

[12] M. Suhlmann, K. Sassenberg, B. Nagengast, and U. Trautwein, "Belonging Mediates Effects of Student-University Fit on Well-Being, Motivation, and Dropout Intention," *Soc. Psychol. (Gott).*, 2018.

[13] J. L. Holland, "Exploring careers with a typology: What we have learned and some new directions.," *Am. Psychol.*, vol. 51, no. 4, p. 397, 1996.

[14] J. L. Holland, "Exploring careers with a typology: What we have learned and some new directions," *Am. Psychol.*, vol. 51, no. 4, p. 397, 1966.

[15] K. A. Feldman, J. C. Smart, and C. A. Ethington, "Major field and person-environment fit: Using Holland's theory to study change and stability of college students," *J. Higher Educ.*, vol. 70, no. 6, pp. 642–669, 1999.

[16] T. L. Strayhorn, *College Students' Sense of Belonging*, 1st ed. New York: Taylor & Francis, 2012.

[17] D. Verdin and A. Godwin, "Understanding how Engineering Identity and Belongingness Predict Grit for First-Generation College Students," in *Proceedings of the Collaborative Network for Engineering and Computing Diversity Conference*, 2018.

[18] D. Verdín and A. Godwin, "First-Generation College Students Identifying as Future Engineers," in *American Educational Research Association*, 2018.

[19] M. Emirbayer and A. Mische, "What is agency?," *Am. J. Sociol.*, vol. 103, no. 4, pp. 962–1023, 1998.

[20] M. Schlosser, "Agency," in *The Stanford Encyclopedia of Philosophy*, Fall 2015., E. N. Zalta, Ed. Metaphysics Research Lab, Stanford University, 2015.

[21] D. Holland, W. Lachicotte, D. Skinner, and C. Cain, *Identity and Agency in Cultural Worlds*. 1998.

[22] A. Eteläpelto, K. Vähäsantanen, P. Hökkä, and S. Paloniemi, "What is agency? Conceptualizing professional agency at work," *Educ. Res. Rev.*, vol. 10, pp. 45–65, 2013.

[23] S. Hitlin and G. H. Elder, "Agency: An Empirical Model of an Abstract Concept," *Adv. Life Course Res.*, vol. 11, no. 6, pp. 33–67, 2007.

[24] J. Lee, K. Lee, and D. L. Schallart, "Sense of belonging and academic engagmenet in the college classroo: A structural equation modeling approach," in *American Educational Research Association*, 2018.

[25] E. A. Bovee, Y. Lee, D. Briedis, P. Walton, and L. Linnenbrink-Garcia, "Making Connections: Belonging in Engineering Fosters Career Intentions through value," in *American Educational Research Association*, 2018.

[26] D. P. Giddens, R. E. Borchelt, V. R. Carter, W. S. Hammack, L. H. Jamieson, J. H. Johnson, V. Kramer, P. J. Natale, D. a. Scheufele, and J. F. Sullivan, *Changing the conversation: messages for improving public understanding of engineering*. 2008.

[27] Accreditation Board for Engineering and Technology, "Criteria for Accrediting Engineering Programs for implementation in the 2019-2020 accreditation cycle," 2018.

[28] D. Riley, "Rigor/Us: Building Boundaries and Disciplining Diversity with Standards of Merit," *Eng. Stud.*, vol. 9, no. 3, pp. 249–265, 2017.

[29] I. Ngambeki, O. Dalrymple, and D. Evangelou, "Decision Making In First Year Engineering : Exploring How Students Decide About Future Studies And Career Pathways," in *American Society of Engineering Education*, 2009.

[30] I. B. Ngambeki, "Finding a home in engineering: Examining students' choice of engineering discipline," *Theses Diss. Available from ProQuest*, vol. 9, pp. 1–143, 2012.

[31] B. A. Danielak, A. Gupta, and A. Elby, "Marginalized Identities of Sense-Makers : Reframing Engineering Student Retention," vol. 103, no. 1, pp. 8–44, 2014.

[32] R. Coogler, *"Black Panther"- The Women of Wakanda*. YouTube, 2018.