# Co-constructing Engineering Doctoral Identities Through Career Prospects

Laura A. Gelles
Shiley-Marcos School of Engineering
University of San Diego
San Diego, CA, USA
lgelles@sandiego.edu

Idalis Villanueva
Associate Professor, Engineering Education
University of Florida
Gainsville, FL, USA
i.villanueva@ufl.edu

*Abstract*— **This WIP research paper explores how engineering doctoral identity influences the perceived career prospects and resources of domestic engineering doctoral students. The qualitative research methodology of Narrative Inquiry was used to highlight the experiences or 'stories' of nine domestic engineering doctoral students from in-depth interviews at a research institution within the western United States. This WIP paper will focus on one of three themes, Engineering Doctoral Identity, that emerged from thematic analysis of the data. This analysis revealed that the aggregate perspectives of student participants revealed a co-constructed engineering doctoral identity. This identity was formed primarily in response to 'insiders', or people who have or are pursuing a Ph.D. in engineering. On the other hand, doctoral student participants had to manage their perceived fit with 'outsiders' who assess the utility of a Ph.D. in engineering for employment. Doctoral student perception and utilization of resources was also influenced by insiders (i.e., engineering faculty), which revealed a preference for resources offered by insiders. Career resources offered by major professors/research advisors were highly regarded and sought after by participants while those offered by Career Services were not pursued at all.**

*Keywords—doctoral students, engineering, identity, career development, academia*

## I. INTRODUCTION

Recruiting and retaining doctoral students is important to ensuring faculty productivity, especially in disciplines such as engineering where individuals can attain a well-paying job with a bachelor's or master's degree [1]–[3]. Doctoral students receive the training and skills to become an independent researcher while simultaneously assisting faculty with research and teaching. However, doctoral students may lack the support or resources to pursue the job position of their choice, especially for non-academic positions [4]. Therefore, it is important to provide them with opportunities, training, and information (i.e., resources) about different types of careers to not only ensure they are productive contributors of teaching and research, but also equip them for future career prospects.

Career prospects are important at all stages of their doctoral experience (i.e., entry, integration, candidacy) and are an important factor in doctoral student retention [5] – [8]. Doctoral students' intention to quit has been linked to factors including lack of employability, lack of career prospects, and a poor job market for Ph.D.s [1], [9]. Providing this type of career advice and support (including professional development opportunities) is typically an expected function of a student's research advisor or mentor [10]–[14]. However, doctoral students and recent doctoral recipients report that they do not receive adequate career information before or during their Ph.D. program [15], especially for careers outside of academia [4], [16], [17]. This is salient for the field of engineering where only 13% of new Ph.D. recipients in engineering report academic commitments, which is consistently the lowest among all disciplines [18]. This indicates that there may be a mismatch between a student's personal career goals, the training and support they receive, and the multiple career options they pursue [19].

This WIP paper will discuss how the formation and negotiation of an Engineering Doctoral Identity influenced the types of resources Engineering Doctoral Students (EDS) sought out for their prospective careers.

## II. THEORETICAL FRAMEWORK

This study is grounded in the combination of Gardner's Theory of Doctoral Student Development [20], and Person-Vocation (PV) Fit in the context of doctoral study [21] as a theoretical framework. Gardner's theory of doctoral student development describes three stages of doctoral student experience. The three stages are: (1) Entry: prior to admission and first semester; (2) Integration: second semester to the qualifying exam; and (3) Candidacy: after qualifying exam to graduation. Each stage has their respective challenges that must be met with appropriate support structures. For example, during the candidacy phase, doctoral students face the challenge of completing a dissertation while also searching for a job. To overcome this challenge, the student could utilize time management skills they developed over the course of their study and seek advice from peers in a similar situation and faculty who have also experienced this. Person-Vocation (PV)

fit is a sub-theory within Fit theory [21], [22]. PV fit describes the positive feelings an individual has towards a profession and the tasks and experiences required for that profession [21]. PV fit posits that an individual will persist in a profession if there is a congruence between the individual and their work environment [23]. For doctoral students, this fit would be with their academic experiences and perceived career options [21].

The combination of these frameworks surmises that doctoral students will develop over time if they have the appropriate supports (e.g., resources) which helps them to meet the various challenges of their program and which align with their vocational interest [20], [21]. For this study, a resource is defined as information, people, recommendations, trainings, or other assets that can be used to help doctoral students develop the skills needed to become a more attractive candidate for hire in their chosen profession or help them with their job search process. Supports as they are characterized in Gardner's Theory of Doctoral Development [20] include individuals who provide these resources and/or other psychosocial support (e.g., mentors, university staff) and embedded structures that provide opportunities for doctoral students to develop the necessary skills and aptitudes needed in their intended profession.

## III. METHODS

This paper is situated within a larger study [24] which sought to explore the perceived career prospects of domestic EDS through Narrative Inquiry [25], [26] and how those different career prospects (non-academic vs. academic) influenced the types of resources they pursued. While the limited scope of this WIP paper cannot adequately capture the participants' stories, a combined EDS narrative is presented within the larger study [24].

Nine current or recently graduated engineering domestic doctoral students at a research intensive Predominantly White Institution (PWI) within the western United States participated in this study. Domestic EDS were recruited from four engineering departments through purposeful sampling and supplemented by convenience and snowball sampling to increase participation [26]. There were 2 women and 7 men in the study and all participants were White. The majority of participants (5 out of 9) received their previous degree(s) from their current institution. Participants ranged from being in their first semester of doctoral study to being recently graduated and having their degrees posted. These mapped along the three stages of doctoral student development (i.e., entry, integration, and candidacy) with recent graduates being added as a fourth category. All participants were funded through an assistantship or fellowship, and one had outside employment as an engineer in industry. Additional information about the participants is provided in Table 1. As there was a small population pool to draw from, gender and engineering discipline are omitted to preserve respondents' anonymity. For example, one engineering department only had two domestic students that met the recruitment criteria.

Data were collected from EDS participants through semi-structured interviews and analyzed using literary (i.e., dramaturgical) and *a priori* coding methods and thematic analysis [26] – [28].

TABLE I. LIST OF PARTICIPANTS AND THEIR CURRENT PHASE OF ENGINEERING DOCTORAL STUDENT DEVELOPMENT.

| Participant ID | Development Phase | Have a M.S. degree | M.S. degree in same field as Ph.D. |
|---|---|---|---|
| DS #1 | Candidacy | Yes | Yes |
| DS #2 | Candidacy | Yes | No |
| DS #3 | Recent Graduate | Yes | No |
| DS #4 | Entry | Yes | No |
| DS #5 | Recent Graduate | Yes | No |
| DS #6 | Integration | Yes | Yes |
| DS #7 | Integration | Yes | Yes |
| DS #8 | Integration | No | N/A |
| DS #9 | Integration | Yes | Yes |

## IV. RESULTS

Thematic analysis yielded the emergence of three themes: (1) Engineering Doctoral Identity; (2) Engineering Doctoral Skill Development; and (3) Time. This WIP paper will primarily focus on the first theme of Engineering Doctoral Identity.

Throughout their narrative interviews, EDS described their experiences and what it meant to be a doctoral student within the discipline of engineering. While each participant had unique experiences and contexts, their aggregate perspectives revealed an Engineering Doctoral Identity (EDI) that evolved throughout their time in their doctoral program and was co-constructed with individuals in their department such as faculty and other doctoral students (i.e., 'insiders'). EDS also perceived the influence of 'outsiders' (i.e., individuals without a Ph.D. in engineering) and how to shape their identity respective to them, especially if they were considering careers outside of academia. EDI was primarily shaped by insiders who had a say in how well a student 'fit' within their departments. This resulted in an internal tension within participants between meeting the expectations and requirements of what insiders determined what made an EDS successful and what skills (e.g., teaching) the participants perceived were important for their future careers.

### A. Insiders

When considering the EDI from an insider perspective, research emerged as central to this identity. Research was so valued by the participants that 8 out of 9 participants explicitly emphasized skills and aptitudes related to conducting research (e.g., specific research techniques, working independently) as important to their current role and future careers. Also, participants indicated how faculty research advisors reinforced the importance of research and instilled these values and aptitudes (e.g., precision, technical competency, innovation) into their students and through corresponding metrics of success (e.g., publishing papers, presenting in conferences). This finding was in spite of the fact that the majority of participants (5 out of 9) preferred careers that did not emphasize research (e.g., teaching, helping others). Moreover, participants emphasized their Ph.D. dissertations as a rite of passage and a way to prove to other academics (i.e., insiders) that they knew how to conduct research. For example, a recent graduate stated:

*The purpose of the dissertation is simply to show your committee that you know how to do research in the field. You understand what methods are appropriate, you*

*understand how to state a problem, and do the methodology to say here's the correct method to answer that question and how to collect the data and how to analyze it. And that is all you have to do. So, really, a dissertation is like a research paper.* (DS #3, Recent Graduate, Line 67)

This focus on research often caused a strain for participants who were interested in teaching-focused careers and wanted to develop their teaching skills. These participants had to individually seek out and make time for professional development opportunities related to teaching within but mostly outside of their program. Participants at all stages of doctoral student development were aware of teaching being secondary to research. Participants stressed that they were not being barred or overtly discouraged from pursuing teaching opportunities by their research advisors, but rather they were not actively supported and had to ensure that met their research obligations first.

## B. Outsiders

Depending on what type of career the participants were considering, EDI was influenced by 'outsiders', or individuals who do not have Ph.D.s and/or are outside of engineering. Outsiders could be prospective employers in industry who assess the utility of hiring engineers with a Ph.D. versus a bachelor's or master's degree. In the context of the university, outsiders also included university staff that participants have or could potentially interact with because they offer career services or have professional responsibilities towards graduate students (e.g., Career Services staff). Outsiders played a role in influencing how the participants navigated their individual EDI, especially if those participants were considering or applying for careers outside of academia. Participants expressed awareness that some employers may not necessarily know what getting a Ph.D. entails or what skills and aptitudes they have. Generally, the participants believed that non-academic employers would see their degree in a positive light, and they would be able to start at a higher pay and prestige level than engineers without a Ph.D. However, participants also expressed that employers could potentially view them as overqualified or too much of a perfectionist due to misconceptions or stereotypes about Ph.D.s. For example, one participant stated about the perception of non-academic employers:

*I think there is a level of, I don't know, respect or trust in the work of a Ph.D. but I think it also, in some ways, it borders on an idea that you give a project to a Ph.D. it might not ever get done because of the perfectionism required with it. So I think that might be the general, the feel, in the industry of you do a Ph.D....you know, if you hire a Ph.D., you get a huge amount of skill set, but then you might also get the downside of too much skill...[...] depending on the person, they're like, "Oh goodness, a Ph.D.." It's like, "We'll get a good answer, but we'll get it in 17 years." So sometimes there's always that joke that,*

*you know, going around too.* (DS #8, Integration Phase, Line 46)

When negotiating between the skills they currently had and were gaining and how employers would see them, the participants expressed that there had to be a certain level of match between the employers needs and what they personally wanted for their careers. One participant expressed that while engineers with Ph.D.s are qualified for jobs that can be done by an engineer with a bachelor's degree, they would not necessarily enjoy the work because it would not allow them to be innovative or develop new techniques to solve new problems. While participants acknowledged that some Ph.D. recipients would be willing to overlook a lower salary or other factors, employers may still perceive the potential candidate as a risk if there is a mismatch in job function or the needs of industry. This was exemplified by some participants' belief that industry was focused on creating products while a Ph.D. was mainly concerned with theory. This product vs. theory view resulted in the perception that Ph.D.s were inefficient.

This potential mismatch in the skills and aptitudes of engineers with Ph.D.s and industry needs also manifested in how participants described the differences between an engineer with and without a Ph.D. Several participants described engineers without a Ph.D. in more of a technician role that performed routine tasks. This description was reinforced by insiders. For example, one participant described some career advice their research advisor gave them:

*So, a bachelor's degree might be more just mundane, routine work, doing the same thing over and over again, just applying it differently. And design work would be maybe for the higher degrees. So, advice like that and then maybe just advice as to try to find what kinda career would best suit me type of thing.* (DS #9, Integration Phase, Line 99)

## C. Negotiation of Identity

Participants of all stages of development (i.e., entry, integration, candidacy) and of all intended career paths were in the process of making sense what it meant to have a Ph.D. within their field and how that would affect their future careers. Participants internalized the norms and values of an EDI, but some found vocational misalignments difficult to deal with. The participants considered multiple career options with certain preferences (e.g., academia), but they were much less flexible on the career function—or what activities they would primarily perform within their job. Participants who preferred research career functions found themselves more aligned with the requirements and outcomes of their doctoral programs. However, the high value placed on research as part of the EDI came at the cost of relatively devaluing other skills (e.g., teaching). Professional development opportunities and career resources that aligned with the EDI were more easily available and supported, while opportunities to build teaching skills were not as easily accessible. Participants interested primarily in teaching career functions had to go out of their way to find opportunities to develop those skills. For example, one participant described changing their program of study several

times to take education courses. Additionally, insiders influenced what career resources the participants utilized. When asked what career resources they utilized or who they went to for support, participants overwhelmingly brought up their research advisor or other insiders like faculty from their department and their peers. The participants were more likely to value and seek out career advice and help from insiders over outsiders such as university staff from Career Services. This was true for both academic and non-academic careers. For example, one participant stated:

> *I'm assuming that my advisor who got hired four years ago, and the new guy in our department, and all these people, I'm assuming they know how to get a job better [than Career Services] also because they're on the hiring committee. Who else is gonna tell me how I'm gonna get hired better than those that are actually hiring?* (DS #1, Candidacy Phase, Lines 133-134)

The participants also sought out resources that could be classified as both insider and outsider (e.g., the School of Graduate Studies, professional societies), depicted in Table 2. Participants expressed that resources from The School of Graduate Studies, while not as highly specific to their needs, could at least offer advice related to the doctoral part of their identity. For professional societies (e.g., the American Society of Civil Engineers), there were career resources for all levels of engineers and that members of that community also had Ph.D.s in engineering. These resources were contextually specific enough to resonate with the participants' EDI.

## V. DISCUSSION

EDS have to navigate and negotiate a 'fit' between their respective departmental cultures, which prioritize certain skill development activities and resources, and their desired career function (i.e., vocation). In this study, the participants' perceived fit was influenced by their negotiation of an Engineering Doctoral Identity, which was primarily defined by insiders who determine what is valued and rewarded. Research has shown that a faculty member's conception of what it means to be a researcher or academic can be misaligned with their graduate students [29]. This was especially true for participants in this study who preferred teaching related career functions primarily in academia. While participants related that their research advisors were not opposed to pursuing teaching skill development opportunities, they were not actively supportive. While these differences in support can be subtle, when reinforced by program requirements that emphasize research, they can communicate hidden expectations and norms such as the expectation to pursue academic careers[1], [30], [31].

TABLE II.    EDS PREFERRED SOURCES OF CAREER ADVICE OR SUPPORT RANKED BY ORDER OF IMPORTANCE.

| Order of Importance | Source of Career Advice or Support | Classification |
|---|---|---|
| 1 | Primary research advisor | Insider |
| 2 | Faculty | Insider |
| 3 | School of Graduate Studies | Insider/Outsider |
| 4 | Peers | Insider |
| 5 | Professional Societies | Insider/Outsider |
| 6 | Career Services | Outsider |

Engrained in the development of doctoral students are the socialization processes of 'becoming' that involves learning how to think and act like a member of their disciplinary community [32]. In this process, the students are reacting to and co-constructing a role identity with the individuals who are currently in that role such as academic insiders [33], [34]. The participants in this study were considering multiple types of careers, and their perceptions of what future employers conceptualized about their role identity was also important. This type of role-identity development is a continuous negotiation that requires insiders to legitimize the individual and also for the individual to accept and internalize that identity (i.e., self-verification) [33], [35]. The participants in this study expressed awareness of norms such as valuing research and the importance of publishing as a metric of success and were willing to perform these tasks to be successful. On the other hand, doctoral students who do not align themselves with the norms and values of their discipline are at risk of being marginalized [36].

Interestingly, in defining their own Engineering Doctoral Identity, participants redefined an engineering professional identity for engineers without Ph.D.s. While undergraduate programs would describe the engineers as innovative and creative problem solvers, the participants ascribed those skills solely to engineers with Ph.D.s and demoted the status of engineers without Ph.D.s. In a study of masters and doctoral engineering students, Choe and Borrego found a negative relationship between engineering disciplinary identity and interest in academic careers [37]. It is possible that this may have consequences for how EDS approach job searches for alternate-academic positions such as those in industry. As participants noted, the Ph.D. degree simultaneously opened up the careers they were qualified for that are unavailable to bachelor's degree graduates (especially involving research), but it also narrowed the types of jobs they would apply to.

### A. Limitations

This study is limited in that it is conducted on a narrow and homogenous population at one research-intensive institution within the western United States. The results of this study cannot be generalizable to other institutions, but some findings are transferable to other institutions with engineering doctoral students. This study was also limited by the small participation population that could be sampled from. It is important to acknowledge that the participants who self-selected into the study were all White and mostly male. Because of this, their individual stories were similar and this research may have limited transferability to underrepresented domestic students in engineering doctoral programs who likely have different career considerations.

## VI. FUTURE WORK

Future work will explore the other two themes (i.e., Engineering Doctoral Skill Development and Time) that emerged from this analysis. Additionally, the perspectives of underrepresented doctoral students and international students should be sought out to explore how they negotiate their Engineering Doctoral Identity.

REFERENCES

[1] C. M. Golde, "The Role of the Department and Discipline in Doctoral Student Attrition: Lessons from Four Departments," *J. Higher Educ.*, vol. 76, no. 6, pp. 669–700, 2005.

[2] C. A. Goldman and W. F. Massy, *The PhD Factory: Training and Employment of Science and Engineering Doctorates in the United States.* Bolton, MA: Anker Publishing Company, Inc., 2011.

[3] D. L. Peters and S. R. Daly, "Returning to graduate school: Expectations of success, values of the degree, and managing the costs," *J. Eng. Educ.*, vol. 102, no. 2, pp. 244–268, 2013.

[4] D. Denecke, K. Feaster, and K. Stone, *Professional development: Shaping effective programs for STEM graduate students.* Washington D.C.: Council of Graduate Schools, 2017.

[5] L. S. Spaulding and A. J. Rockinson-Szapkiw, "Hearing their voices: Factors doctoral candidates attribute to their persistence," *Int. J. Dr. Stud.*, vol. 7, pp. 199–219, 2012.

[6] H. Churchill and T. Sanders, *Getting your PhD: A practical insider's guide. Thousand Oaks*, CA: Sage, 2007.

[7] B. E. Lovitts, *Leaving the ivory tower: The causes and consequences of departure from doctoral study.* New York, NY: Rowman and Littlefield Publishers, Inc., 2001.

[8] C. R. Bair, and J. G. Haworth, "Doctoral student attrition and persistence: A meta-synthesis of research," in *Higher education: Handbook of theory and research*, Dordrecht, Netherlands: Springer, 2004, pp. 481-534.

[9] F. Travaglianti, A. Babic, and I. Hansez, "Relationships between employment quality and intention to quit: focus on PhD candidates as traditional workers," *Stud. Contin. Educ.*, vol. 40, no. 1, pp. 115–131, 2018.

[10] S. Carpenter, N. Makhadmeh, L. Thornton, S. Carpenter, N. Makhadmeh, and L. Thornton, "Mentorship on the Doctoral Level : An Examination of Communication Faculty Mentors ' Traits and Functions Mentorship on the Doctoral Level : An Examination of Communication Faculty Mentors' Traits and Functions," *Commun. Educ.*, vol. 64, no. 3, pp. 366–384, 2017.

[11] J. L. Edwards and S. M. Gordon, "You should--I should: mentoring responsibilities as perceived by faculty, alumni, and students," pp. 1–18, 2006.

[12] Y. N. Lin and A. Y. Hsu, "The perspectives of science and engineering master's students on the mentoring relationship.," *Int. J. Evid. Based Coach. Mentor.*, vol. 11, no. 1, pp. 129–145, 2013.

[13] W. B. Johnson, *On being a mentor, a guide for higher education faculty.* New York, NY: Routledge, Taylor & Francis Group, 2016

[14] W. B. Johnson, G. Rose, and L. Z. Schlosser, "Student–faculty mentoring: Theoretical and methodological issues," in *The Blackwell handbook of mentoring: A multiple perspectives approach.* Malden, MA: Blackwell Publishing, 2007, pp. 49-69.

[15] J. R. Allum, J. D. Kent, and M. T. McCarthy, Understanding PhD career pathways for program improvement: A CGS report. Washington, DC: Council of Graduate Schools, 2014.

[16] H. Sauermann and M. Roach, "Science PhD career preferences: Levels, changes, and advisor encouragement," *PLoS One*, vol. 7, no. 5, pp. 1–9, 2012.

[17] S. L. Laursen, H. Thiry, and C. Liston, "The impact of a university-based school science outreach program on graduate student participants' career paths and professional socialization," *Journal of Higher Education Outreach and Engagement*, vol.16, pp. 47-78, 2012.

[18] National Center for Science and Engineering Statistics, "Doctorate Recipients from U.S. Universities," National Science Foundation report. NSF No. 20-301. December, 2019 [Online]. Available: https://ncses.nsf.gov/pubs/nsf20301/report [Accessed April 9, 2020].

[19] C. Golde and T. Dore, "At Cross Purposes: What the Experiences of Today's Doctoral Students Reveal about Doctoral Education.," Pew Charit. Trust., pp. 1–15, 2001.

[20] S. K. Gardner, "The development of doctoral students: Phases of challenge and support," *ASHE High. Educ. Rep.*, vol. 34, no. 6, pp. 1–14, 2009.

[21] V. L. Baker and M. J. Pifer, "Antecedents and outcomes: theories of fit and the study of doctoral education," *Stud. High. Educ.*, vol. 40, no. 2, pp. 296–310, 2015.

[22] J. A. Chatman, "Matching people and organizations: Selection and socialization in public accounting firms," *Administrative Science Quarterly*, vol. 36, pp. 459–84, 1991.

[23] R. V. Dawis, and L. H. Lofquist, *A psychological theory of work adjustment: An individual differences model and its application.* Minneapolis, MN: University of Minnesota, 1984

[24] L. A. Gelles, "Career prospects and resources of domestic engineering doctoral students," Ph.D. dissertation, Dept. Engineering Education, Utah State University, Logan, UT, 2019.

[25] D. J. Clandinin and F. M. Connelly, *Narrative inquiry: Experience and story in qualitative research.* San Francisco, CA: Jossey-Bass, 2000.

[26] J. W. Creswell, *Qualitative inquiry and research design: Choosing among five approaches.* Thousand Oaks, CA: Sage, 2013.

[27] B. L. Berg, *Qualitative research methods for the social sciences.* Thousand Oaks, CA: Sage, 2001.

[28] Saldaña, J. (2016). *The coding manual for qualitative researchers* (3rd ed.). Los Angeles, CA: Sage.

[29] J. P. Bieber, and L. K. Worley, "Conceptualizing the academic life: Graduate students' perspectives," *The Journal of Higher Education*, vol. 77, pp. 1009-1035, 2006.

[30] L. A. Gelles, I. Villanueva, and M. D. Stefano, "Perceptions of ethical behavior in ethical mentoring relationships between women graduate students and faculty in science and engineering," in *Proc. of the ASEE Annu. Conf. and Expo.*, June 2018.

[31] Lovitts, B. E., *Making the implicit explicit: Creating performance expectations for the dissertation.* Sterling, VA: Stylus, 2007.

[32] C. Golde, "Entering different worlds: Socialization into disciplinary communities," in *On becoming a scholar: Socialization and development in doctoral education*, S. K. Gardner and P. Mendoza, Eds. Sterling, VA: Stylus Publishing, 2010, pp. 79-95.

[33] G. J. McCall, "The me and the not‐me: Positive and negative poles of identity," in *Advances in identity theory and research*, P. J. Burke, T. J. Owens, R. T. Serpe, and P. A. Thoits, Eds. New York: Kluwer Academic/Plenum, pp. 11‐26, 2003.

[34] J. E. Stets and M. M. Harrod, "Verification across multiple identities: The role of status," *Social Psychology Quarterly*, vol. 67, pp. 155-171, 2004.

[35] J. P. Gee, *How to do discourse analysis: A toolkit.* London, United Kingdom: Routledge, 2010.

[36] L. Hall, and L. Burns, "Identity development and mentoring in doctoral education," *Harvard Educational Review*, vol. 79, pp. 49-70, 2009.

[37] N. H. Choe and M. Borrego, "Master's and doctoral engineering students' interest in industry, academia, and government careers," *J. Eng. Educ.*, pp. 1–22, 2020.